Sky and TELESCOPE

In This Issue:

Applications of the Rocket Engine

Motions in Gaseous Nebulae

A Provisional List of the Major Meteor Showers

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Travel Plans to a Seven-Minute Eclipse

WHAT celestial event can compare, for the astronomically minded, with a total eclipse of the sun lasting seven minutes? On June 20th this year the moon's shadow will cross the Philippines, passing 30 miles south-southwest of the Manila Observatory shortly after noon. The duration of totality on the center line there will be seven minutes and three seconds, only 37 seconds short of the longest possible, and more than 5½ times as long as at Minneapolis last June 30th.

This is the longest totality since the eclipse of June 8-9, 1937, which was visible in Peru and from a few Pacific islands. Manila can be reached in a few days by air from the West Coast of the United States.

Fortunate indeed is Hans Arbet, a member-at-large of the Astronomical League, who lives in Manila and writes to former league president Charles H. LeRoy, of Pittsburgh:

"I am making full preparations for the total solar eclipse on June 20th. My only fear is that since this time falls into the rainy season of this country, the sky may be overcast. Chances are only about 50-50 that we will succeed."

One way to get to the eclipse has been worked out by former league treasurer Carl P. Richards, of Salem, Ore., in collaboration with the Globe Travel Service. Their proposed itinerary combines the attractions of an Oriental cruise (traveling by air tourist, Pan American and Northwest Orient) with a stay in Manila that includes four days for setting up eclipse equipment.

The traveler will leave Portland on Saturday, June 11th, will spend 2½ days in Hawaii, 5½ in Manila, three in Hong Kong, five in Japan, overnight at Anchorage, Alaska, and return to Seattle on Thursday, June 30th, in time for the general convention of the Astronomical League there July 1-5. So those who already expect to attend the convention would need 2½ weeks additional time for the trip to Manila.

This tour is being supported by the Astronomical League and by *Sky and Telescope*, in the belief that all amateurs and professionals should know of the relative accessibility of such an unusual and important astronomical event. Mr. Richards himself will act as unofficial guide for the group, and *Sky and Telescope* will advise on problems of organization, instruments, and technical information of a general character.

The estimated cost of about $1,250 covers tourist airline transportation and tax; it includes first-class hotels, some meals, and most ground transportation. After a deposit of $50 and a registration fee of $10 per person, the Globe Travel

(Continued on page 101)

Applications of the Rocket Engine

FREDERICK I. ORDWAY, *American Astronautical Society*

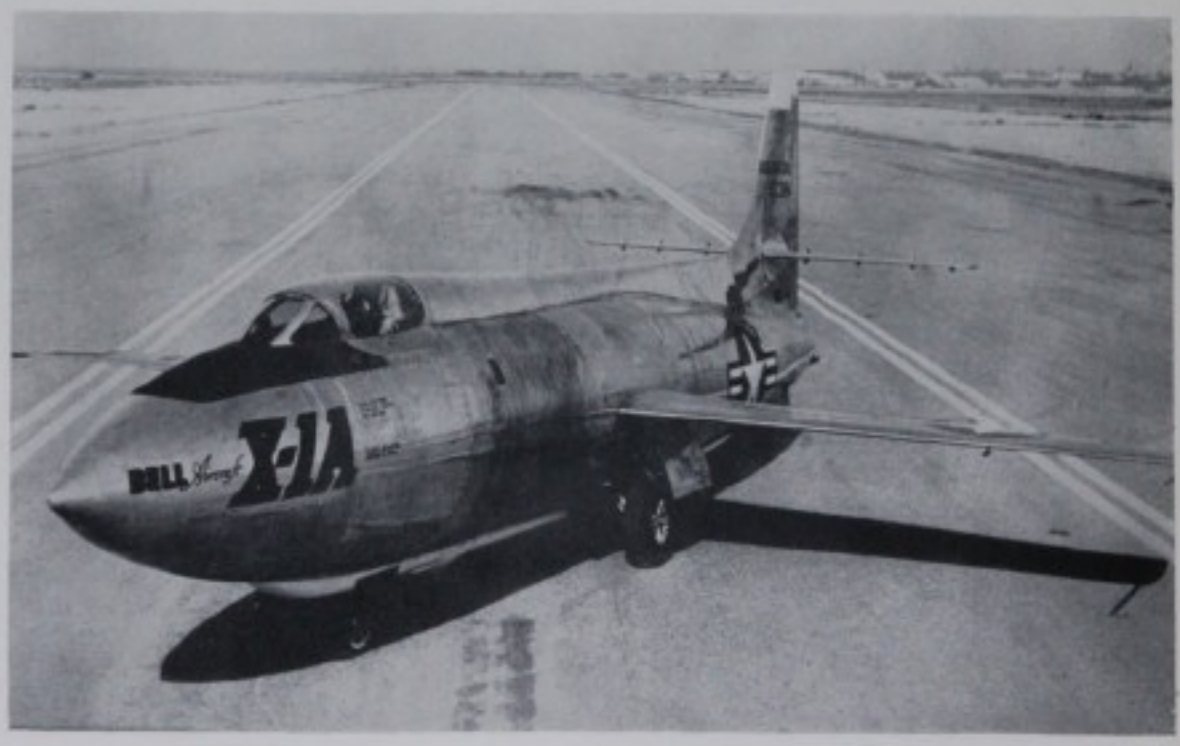
DURING the long interval between the early Chinese "fire arrows" and modern high-altitude missiles, there were few significant chapters in rocket history. In India, in the 1790's, iron-cased war rockets were used against British positions. The inventiveness of Sir William Congreve and the experience in India led the British to organize a rocket corps in their own army. Thousands of Congreve rockets were fired against Copenhagen in 1807. Rocket units were attached to the armies of most other European nations. Soon, however, the improvement of rifling in cannons pushed the not-too-accurate rocket into the background.

The development of the modern rocket began a generation ago independently in Europe and America. The Europeans were less conservative in their combination of theory and experiment. Their object was admittedly space flight, and they were not ashamed to write about and work toward this distant goal. Oddly, the interplanetary theme was viewed as absurd by the usually forward-looking American public; the reputation of a scientist was in no way aided by association with a group promoting space travel. This negative attitude, now largely history, held America far behind in the rocket field until after World War II.

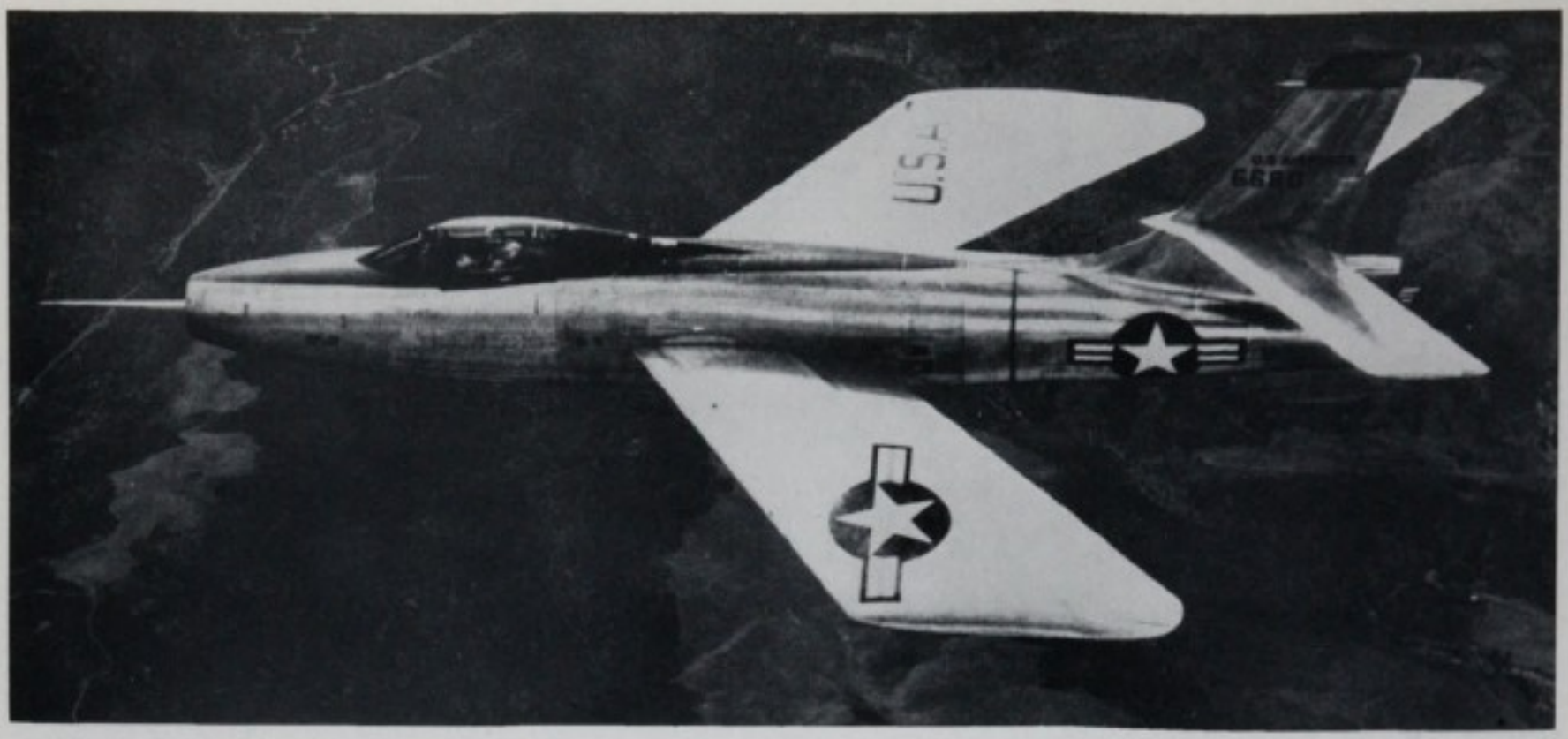
In Germany in the late '20's a space-flight society grew up, and soon became actively engaged in liquid-propellant rocket tests. Under Hitler the military use of rocket instruments was revived. The German military, which took over from the space-flight society, constructed a huge experimental base at Peenemunde, on the Baltic Sea. Here, preceded by several small test rockets, the famed V-2 emerged upon the chaotic World War II scene. The first successful test firing of one of these gigantic 56,000-pound-thrust missiles was in October, 1942. Soon the rocket, which could attain more than 160-mile ranges, was being produced in underground plants at a rate reaching 30 units a day.

The Germans also developed a variety of glide bombs, rocket-powered aircraft, and air-to-air, ground-to-air missiles.

Among the most recent rocket developments is the Navy Pogo, a 13½-foot solid-propellant rocket, here seen taking off from its portable launcher at White Sands Proving Ground in New Mexico. The Pogo will reach an altitude of about 40,000 feet, where a parachute 20 feet in diameter will be spring released from the rocket's nose. The parachute fabric is coated with a thin layer of metallic silver to reflect radar signals; it will resemble an airplane on ground radar scopes. Thus, as it floats down slowly, the Pogo parachute will provide the first inexpensive high-altitude target to be developed for guided missile research. Official U. S. Navy photograph.



The Bell X-1A rocket plane is believed to have set a new altitude record for manned flight, according to "Jet Propulsion," journal of the American Rocket Society, when Major Arthur Murray piloted the X-1A to 90,000 feet at Edwards Air Force Base. Reaction Motors, Inc., photograph.



The Republic XF-91 is a high-altitude interceptor fighter plane, powered by a General Electric 5,200-pound-thrust turbojet engine plus afterburner. For emergency power it has a Reaction Motors 6,000-pound-thrust rocket engine. It was the first combat-type aircraft to make several flights at supersonic speeds. The swept-back wings have inverse taper, and may be set at various angles. Republic Aviation Corporation photograph.

Their work in the field rivals British radar and American atomic bomb projects as World War II scientific achievements.

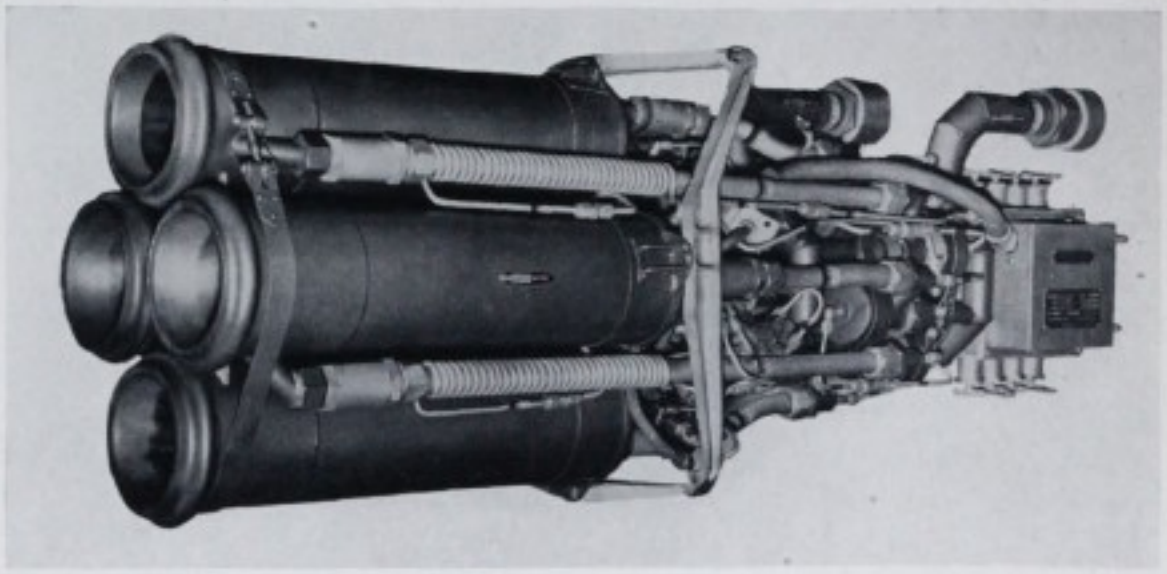
Significant American experimental rocket engine work followed the war, although much had been accomplished in the earlier experiments by Dr. Robert Goddard, the American Rocket Society, and others. Four members of the society in 1941 founded America's first company devoted solely to rocket engines, Reaction Motors, Inc., of Rockaway, N. J.

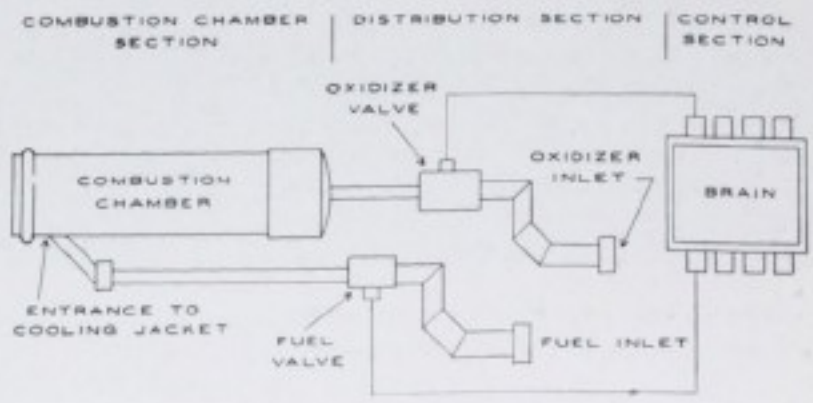
The early rocket engines by R.M.I. were based on the Wyld 100-pound-thrust alcohol-oxygen unit, mentioned in last month's article, "Principles of the Rocket Engine." Gradually the size of the engines increased until 3,000-pound-thrust readings were obtained. The first liquid-propellant assist-take-off (ATO) unit made in America was by R.M.I.; it lifted a heavily loaded Navy PBM-3C from the water in January, 1944. In the same year work began on two-chamber engines exerting 620 pounds of thrust. These nitric acid-aniline engines, hundreds of which have been delivered, have powered Navy Lark subsonic guided missiles (one of these was pictured last month).

The development of a 1,500-pound-thrust chamber followed; by 1948 R.M.I. had produced a 6,000-pound-thrust engine comprising four of these units to power the Air Force X-1 research aircraft. The X-1 was the first plane to cross the sonic barrier in level flight. The Bell X-1A is an improved version that uses a turbopump rather than a pressurized feed system. Major C. Yeager flew an X-1A at 1,600 miles per hour on December 12, 1953, over Edwards Air Force Base, Calif.

Other planes using the same rocket engine are the Air Force Republic fighter XF-91 and the Navy Douglas D-558-2 Skyrocket (shown last month on page 50). The Skyrocket has reached altitudes over 83,000 feet.

The 6,000-pound-thrust R.M.I. multiple-chamber rocket engine, model 1500-N4C, is illustrated. It weighs only 210 pounds. Like all rocket engines, it consists of a combustion chamber section, distribution system, and a brain or control section. The control box gives the orders to the engine, either automatically, or relayed by pilot command. Thus the engine may be turned on or off, automatically shut off should anything go wrong, and so on. The distribution system is essentially plumbing to deliver the propel-





This multiple-chamber 6,000-pound-thrust engine by Reaction Motors, Inc., is constructed on the plan of the schematic drawing at the right, where only one combustion chamber is shown.

lants to the combustion chamber under controlled conditions. The combustion or firing section receives the propellants, injects and mixes them, and burns the fuel.

One propellant, here the oxidizer, goes directly through its valve to the chamber; the fuel (ethyl alcohol and water) first passes to the nozzle end into the cooling jacket. After circulating through the jacket and cooling the combustion chamber, it is injected and mixed with atomized liquid oxygen.

Each chamber is independent of the others, and may be turned on or off at will. Thus an aircraft powered with this engine can be operated at thrust levels of 1,500, 3,000, 4,500, or 6,000 pounds.

The connecting link between today's rocket aircraft and tomorrow's interplanetary rocket is the upper-atmosphere research vehicle. After German progress in rocketry came to an end with Hitler's defeat, the United States converted captured V-2's to begin an active upper-atmosphere research program. The V-2's, together with American-built Aerobees and WAC Corporals, carried on this work until high-performance American missiles could be developed.

This object was achieved when, on September 17, 1947, an R.M.I. four-chamber 8,000-pound-thrust engine drove an Air Force MX-774 missile into the upper atmosphere. Later, in 1949, the first of a series of Navy Viking missiles was launched. These vehicles, designed to supersede the V-2, are powered with 20,000-pound-thrust engines. The seventh Viking broke the single-stage missile speed and altitude records in August, 1951. It soared 136 miles high, after having reached a speed of 4,000 miles per hour. The ninth Viking, shorter, fatter, and heavier than the earlier model, has matched this altitude record. The 11th Viking established a 158-mile single-stage record last May. Further improvements in Vikings should make them steppingstones to larger, more advanced rockets.

Rocket missiles of all sorts are being widely tested in Europe, Asia, the Americas, and Australia. British Snarler and French SEPR rocket units have already been installed in research aircraft, and the Russians have improved considerably the German Walter liquid-propellant rocket engine, until the present version develops 6,600 pounds of thrust. This has reportedly been subjected to exhaustive flight testing in the YAK-21 experimental plane.

What will be next on the scene now dominated by modern high-altitude research missiles? Single-stage missiles have reached altitudes of over 150 miles, while the second stage of a V-2 and WAC Corporal combination has attained 250 miles. What must man do to soar yet higher in the atmosphere and into interplanetary space itself? The basic problems in this fight of the missile against gravity can be outlined rather simply.

The rocket engine must deliver as much thrust as possible for each pound of engine weight. In addition, the weights of the missile, propellants, and payload all enter the picture.

There are essentially two methods of improving thrust. We can either increase the exhaust velocity, or increase the mass of the exhaust. Evidently it is far better to step up the speed of the ejected particles than to add to their mass, for the latter would require the rocket to carry a greater weight of propellants.

This brings us to the question of missile speed in terms of exhaust velocity. A rocket can travel faster than the speed of its own exhaust. This is not strange. Suppose it were traveling at exhaust velocity, and that there were still propellants remaining. Combustion could obviously continue to occur, mass could still be ejected, and further acceleration of the rocket could take place. Its speed would thus continue to increase until its fuel was used completely.

Rocket theory shows that for missile speed to equal exhaust speed, the initial loaded weight must be at least 2.72 times the empty missile weight. Otherwise put, the *mass ratio* of the rocket must be at least 2.72. A rocket that weighs 1,000 pounds when empty must carry not less than 1,720 pounds of propellants in order to reach a maximum speed equal to that at which its exhaust is ejected.

To reach higher speeds, the weight of propellants needed increases very rapidly. For a rocket moving at twice exhaust speed the minimum mass ratio is 2.72^2 or 7.4; for three times exhaust speed, 2.72^3 or 20.1. This last would require a monster rocket whose weight would be 95 per cent propellant, and five per cent missile, engine, and payload! This is far beyond present-day engineering; the mass ratio of the V-2 is over 3, of the Viking about 3.5.

This emphasizes the desirability of increasing ejection speed of the exhaust. Tripling the exhaust velocity will provide the same maximum missile speed with a fraction of the loaded rocket weight; our 1,000-pound rocket will need only 1,720 pounds of propellants instead of 19,000. Clearly, it is far better to carry less propellant and eject it more rapidly.

The V-2 exhausts its particles at 4,500 miles per hour, but moves at only 3,600, despite a better than 2.72 mass ratio. The difference between theoretical and actual performance is due to air resistance and gravity. The V-2 achieves about 70 per cent of ideal performance; the Viking does somewhat better.

How close can we come to escape from the earth by rocket? Further increases in exhaust velocities must be achieved in the face of severe engineering limitations. Today's propellants produce exhausts of 4,000 to 5,000 miles per hour. Assuming engineering research can achieve a missile with a mass ratio of 7.4, we may expect under ideal conditions only 10,000-miles-per-hour forward missile velocities (twice 5,000-miles-per-hour exhaust velocity).

For a rocket to recede indefinitely from the earth it must be moving with at least the *velocity of escape*—about 25,000 miles per hour if no allowance is made for air resistance. Any slower missile will not escape from the earth's gravitational attraction and will fall back to the surface.

A speed of 10,000 miles per hour is thus far short of the velocity of escape. Even superior propellants, such as liquid hydrogen, liquid ozone, or liquid fluorine, may not give enough exhaust velocity to span this gap for a single-step rocket. Possibly atomic energy may someday come to the rescue.

The solution of these difficulties will

The 6,000-pound-thrust engine pictured on the preceding page is seen here during experimental firing on a test stand. Three of the four chambers are in operation, while one is standing by. Photograph by Reaction Motors, Inc.

probably depend on the multistage- or *step-rocket*. The step principle is essentially a means of raising mass ratio. In 1949 the nose section of a converted V-2 was fitted with a new type of payload—a small American-made WAC Corporal rocket. The V-2 was fired, and at the moment of propellant exhaustion, when the V-2's speed was a maximum, the WAC Corporal was released. The velocity of the small missile, added to that of the V-2, enabled the WAC Corporal to soar to a world altitude record of 250 miles. This illustrates the aim of the step principle: useless missile weight is disposed of once the contained propellant is consumed.

The final velocity of the WAC Corporal was much greater than either missile could have attained alone, and corresponded to the product of the individual mass ratios. Here is a way to get higher speeds than if all the weight were used in one stage. Our 2,720-pound rocket weight mentioned earlier, if divided into two stages, would net us twice the final velocity than if it were a one-stage affair, assuming the mass ratio of each stage as 2.72; the *effective* mass ratio would, of course, be 7.4.

Thus, if a single-stage rocket can theoretically reach 10,000 miles per hour, two-stage missiles might attain 20,000 miles per hour, and three-stage ones could escape from the earth. Each step would operate under single-missile velocity conditions of 10,000 miles per hour. Limitations are naturally imposed by complexity and high takeoff weight, but we have at least indicated a promising road for future development in rocket technology.

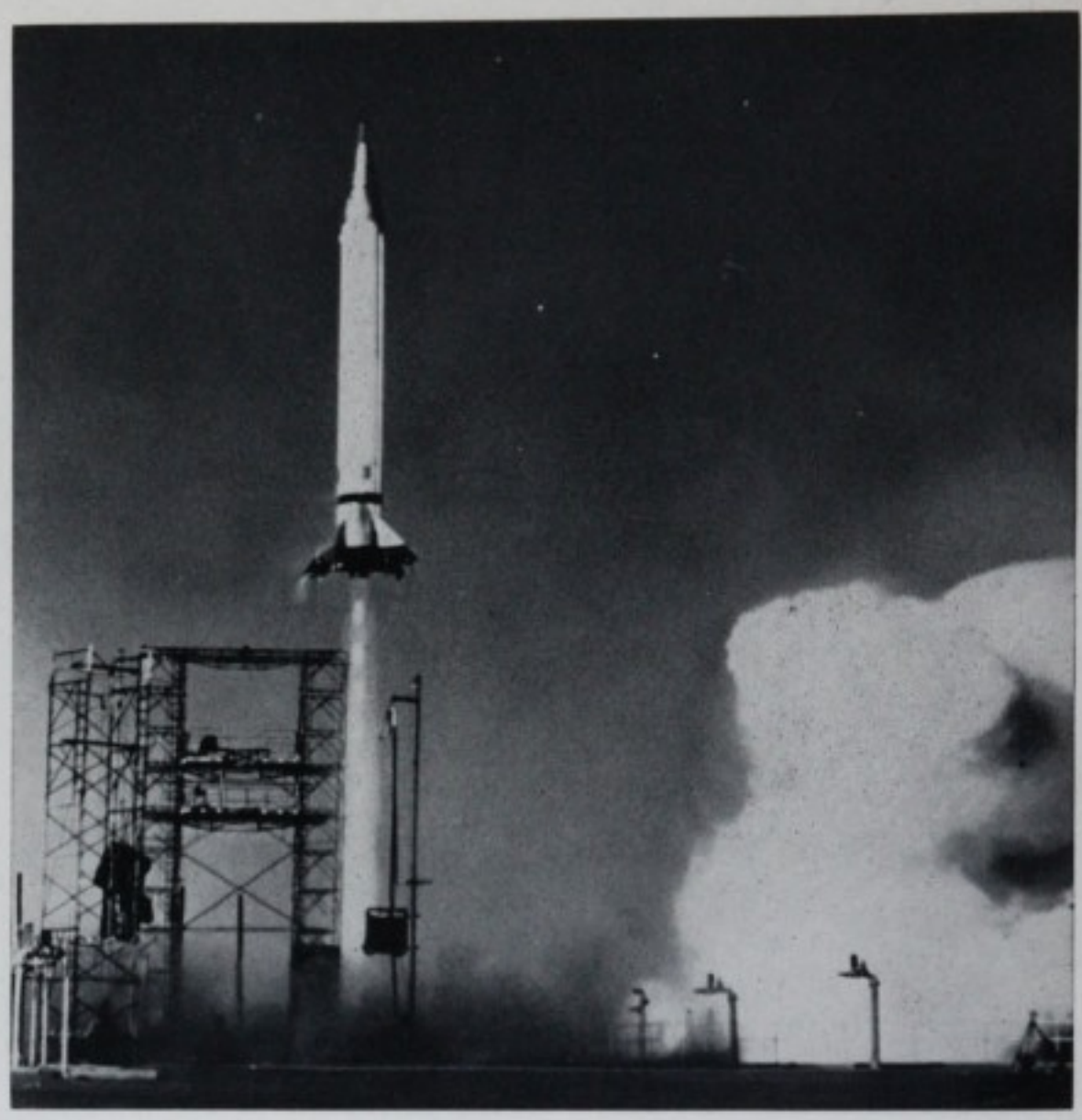
The artificial satellite or space station has been often considered as an intermediate step in the conquest of planetary distances. Less difficult than sending a chemical rocket to the moon would be placing it in a stable orbit around the earth, a thousand or so miles up. A miniature moon like this might be built up from parts and payloads of many rockets arriving from the earth.

The idea of the satellite vehicle apparently originated with Oberth, with later contributions from Noordung, von Pirquet, and many others. An elaborate scheme that is now receiving widespread attention has been proposed by Wernher von Braun, formerly chief of German rocket development at Peenemunde, and now technical director of the Army Ordnance Guided Missile Center, Redstone Arsenal, Alabama.

Von Braun's wheel-shaped satellite station, 1,075 miles above the earth's surface, would circle the earth at 4.4 miles per second. It would be constructed piece by piece from material carried by rockets, which von Braun conceives as enormous three-stage affairs, operating on hydrazine and nitric acid. The first step would be powered by 51 motors producing 14,000 *tons* of thrust. When its propellants were exhausted, it would drop off, and the second step would take over, developing 1,750 tons. Finally, the third step, containing the crew and 36 tons of payload, would reach orbital velocity with the aid of five motors generating 220 tons. After discharging its cargo, a winged final stage would have reserve propellant to return to earth, using the atmosphere to brake its descent.

If all this could be realized, a modified third stage which had been refueled at the satellite base could fly on to the moon without much difficulty. Such a rocket would *start* its journey already moving at the orbital speed of nearly 16,000 miles per hour, and this would have to be increased to a little over 22,000 to escape from the earth's pull at the altitude of the orbit.

Four kinds of research seem basic to further improvement of rockets. We have seen that the engineer must provide missiles with larger mass ratios. He must also perfect the step technique, and devise orbital refueling systems. The chemist has to search for more powerful propellants that will give higher exhaust velocities. Only by the combination of these four activities will rockets eventually enter interplanetary space, as the rocket pioneers envisioned at the beginning of this century.



The ninth Martin Navy Viking rocket, powered by a single-chamber engine delivering 20,000 pounds of thrust, is here seen at takeoff. It matched the 136-mile altitude record of its lighter predecessors. Department of Defense photo.

GIANT RADIO TELESCOPE FOR AUSTRALIA

A radio telescope with a steerable parabolic antenna 250 feet in diameter will be erected near Sydney, New South Wales. An instrument of the same size and type as that now under construction at Manchester, England (*Sky and Telescope*, February, 1953, page 95), it will accomplish for southern skies what the Manchester instrument will do for the northern and, in addition, will be able to study the radio energy of the Magellanic Clouds.

To aid the $11,250,000 project, the Carnegie Corporation of New York made a contribution of $247,500 to the Australian Commonwealth Scientific and Industrial Research Organization. Under the leadership of Dr. F. G. Bowen, the organization's Radiophysics Laboratory has already made notable advances in radio astronomy.

MOTIONS IN GASEOUS NEBULAE

OTTO STRUVE, *Leuschner Observatory, University of California*

THE CLASSICAL method of determining the radial motion of a star or nebula is to measure the Doppler displacements of lines in the spectrum of the celestial object compared with spectral lines from a laboratory source in front of the spectrograph slit.

By such measurements W. W. Campbell and J. H. Moore long ago found that the Orion nebula as a whole recedes from us at 17.5 kilometers per second. But the long bright filament in the upper right part of the central region, and the isolated bright patch in the lower right, are receding at four to seven kilometers per second, relative to the nebula as a whole. On the western edge of the nebula there is a preponderance of velocities of approach, again relative to the mean. But in all parts of the nebula the motions are chaotic, differing by some five to 10 kilometers per second between neighboring points.

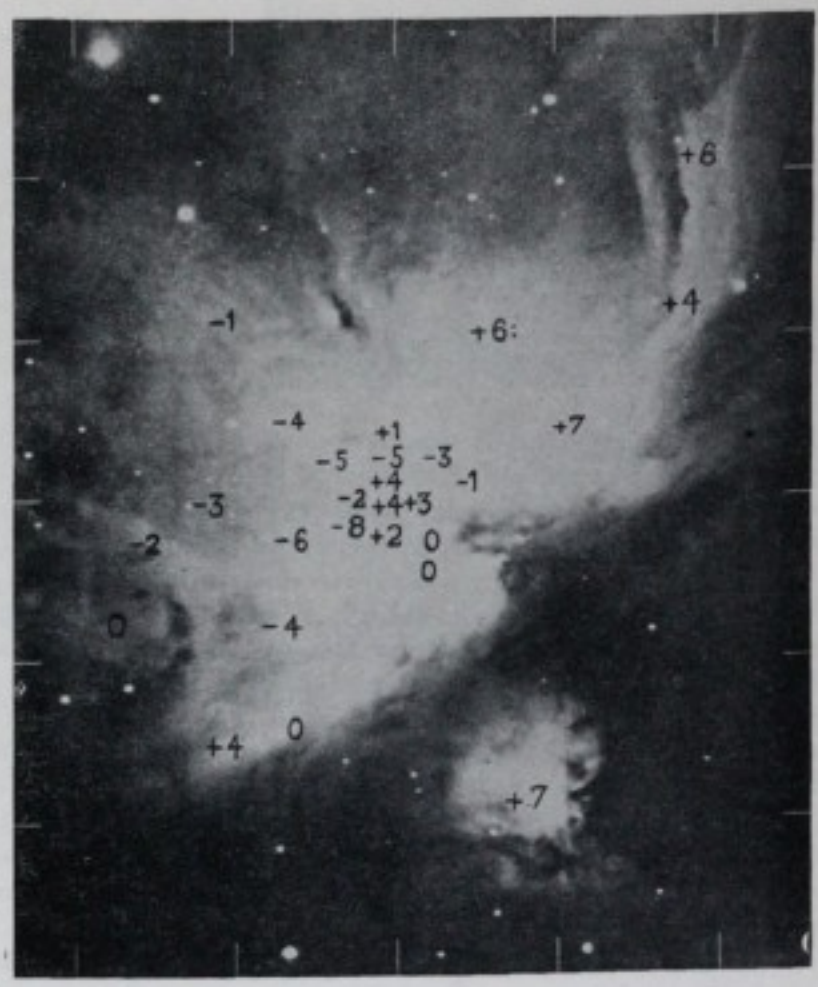
In this early work at Lick Observatory a separate spectrogram was obtained for each point of the nebula — a laborious and time-consuming procedure. It was especially difficult because with a typical stellar spectrograph it is impossible to guide accurately upon a point of the nebula, unless there is a bright star in the field of the eyepiece that can be held upon the crosswires.

An important improvement upon this method has been recently devised by O. C. Wilson and G. Muench at Mount Wilson and Palomar Observatories. The spectrum of an emission nebula consists of a series of bright lines, each of these practically of one wave length, that is, monochromatic. In the new method, filters are used to eliminate all these wave lengths except one. The image of the nebula in the remaining single bright line is projected upon an array of parallel spectrograph slits. The photographic plate then records a pattern of closely spaced strips of the nebula, all in the same radiation. Thus, a single plate may be used to measure the Doppler shifts at many regularly spaced points about 1½ seconds of arc apart.

The results of Wilson and Muench's study of motions in the Orion nebula are being awaited with considerable interest. Even the early Lick observations, irregularly spaced some minutes of arc apart, have enabled C. F. von Weizsaecker and S. von Hoerner to test an important statistical law that describes turbulent motions in a nebula: In a medium of constant density the difference of velocity at two points separated by the distance d is proportional to the cube root of d, or $d^{1/3}$.

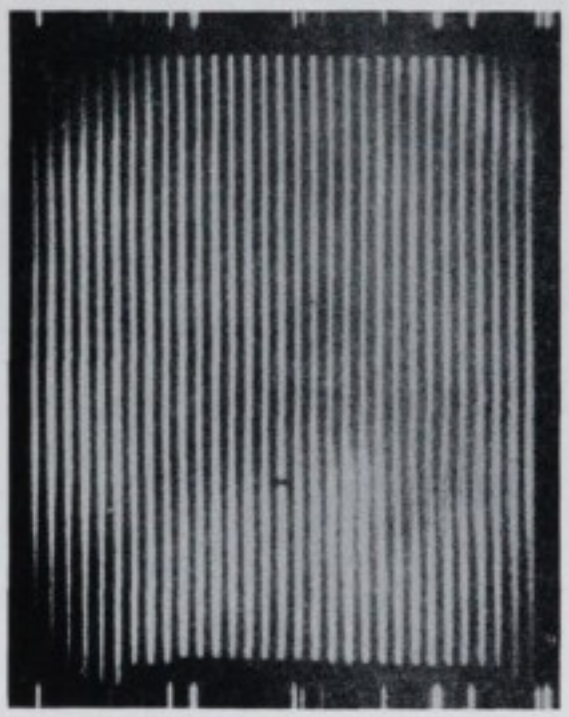
Another method is in some respects even more powerful than that of the stellar spectrograph. This technique uses a Fabry-Perot etalon or interferometer at the plate end of a photographic telescope. The principle is closely related to that of the interference filters described in the January, 1951, issue.

The idea is not new. It was successfully used by C. Fabry, H. Buisson, and H. Bourget about 40 years ago, and by W. Baade and others in 1933 to study the internal motions of the Orion nebula. But in recent years improvements



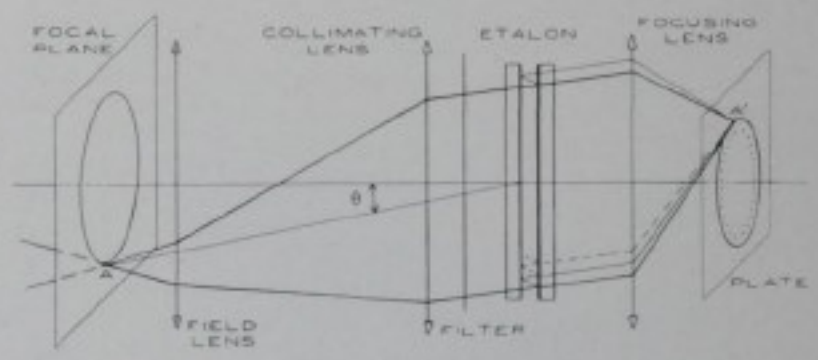
Right: Internal motions in the Orion nebula are shown by Lick Observatory measures of radial velocities, plotted here in kilometers per second, as compared with their mean. Plus numbers indicate recession. The marginal ticks are four minutes of arc apart. From Lick Observatory "Publications," 1918.

Below: A small section, 40 by 40 seconds of arc square, of the Orion nebula, observed by the Wilson-Muench method with the 200-inch telescope, in the light of oxygen at 5007 angstroms. Varying widths of the white strips, 1½ seconds of arc apart, show how the turbulent motions change from point to point.



FACING PICTURE: The "flaming star" nebula IC 405, photographed by the 100-inch Hooker reflector on December 20, 1922, exposure 2¼ hours. At the center of the picture is the greatly overexposed image of AE Aurigae, a 6th-magnitude O-type star that excites the gas to shine. Both star and nebula are about 1,600 light-years away, and may be moving through space together (News Notes, March, 1954). However, at Lick Observatory last winter, N. U. Mayall obtained radial velocities for selected regions of the nebula that differ markedly from the star's motion of 59 kilometers per second away from the sun. Mount Wilson and Palomar Observatories photo.

Some of the parts of the Courtes interferometer, attached to the 47-inch Haute Provence reflector, can be identified in this picture with the aid of the diagram at the right illustrating its operation.



in the construction of the interferometer plates have created an enormous gain in the quality of the observations. The new work which we shall describe this month is that of a young French astronomer, Georges Courtes, a member of the staff of the Marseille Observatory. His observations were made during the past four years with the 120-cm. reflector of the Haute Provence Observatory near St. Michel.

The photograph shows his equipment attached to the telescope. The principle of his procedure can be seen from the diagram. Assume that the image of a nebula in the focal plane of the telescope is represented by the circle. The rays from a point on the circle, *A*, are made parallel by the collimating lens and then pass through a filter to an etalon. The latter consists of two parallel glass plates with partly reflecting layers on their inner faces.

If the angle θ has the proper value, the rays reflected between the plates will reinforce one another and, after passing through the focusing lens, will produce a strong spot at the point *A'*. This will also be true for all points on the circle, which will appear bright on the plate wherever the nebula itself is bright. Points in the focal plane slightly inside or outside the circle will not have the correct value of θ, and will not undergo reinforcement of the reflected rays. Only when θ has certain definite values can there be reinforcement.

If the spacing between the plates is *s*, then reinforcement occurs for all points for which

$$2\,s\cos\theta = n\,\lambda,$$

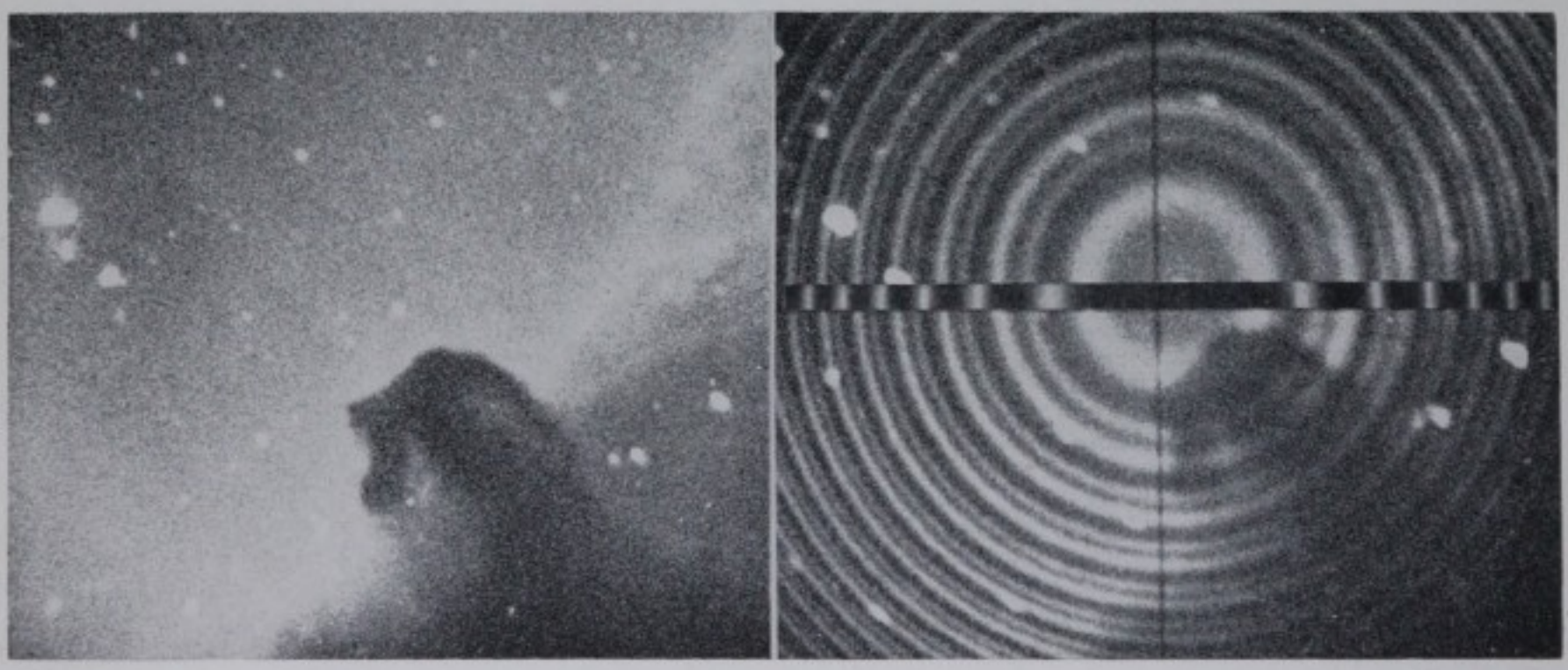
where λ is the wave length of the light. Because of the circular symmetry of the arrangement, the interference maxima produce circles on the photographic plate, each corresponding to a different value of *n*: 1, 2, 3, and so on.

Courtes uses red-sensitive 103a-E plates in order to record the H-alpha line of hydrogen, whose wave length is 6563 angstroms. A red filter cuts out most radiations other than H-alpha and its two neighboring lines of ionized nitrogen that are seen in some of the photographs with this article. The focusing lens may be replaced by a fast Schmidt camera.

Typical of the photographs made in this way is that of the Horsehead nebula in Orion, shown below. At the left is a direct picture, made in H-alpha light without the interferometer device. At the right is an interferometer plate. The more intense series of concentric circles is due to H-alpha light, the fainter are of ionized nitrogen. For each series, the innermost circle corresponds to $n = 1$, the next to $n = 2$, and so on. Three complete hydrogen circles are shown.

Each such interferometer photograph is compared with a similar picture of a white screen illuminated by a laboratory hydrogen discharge tube. Across the right-hand picture is shown a sample strip from one of these laboratory photos; it is seen that the laboratory rings have larger radii than those of the nebula.

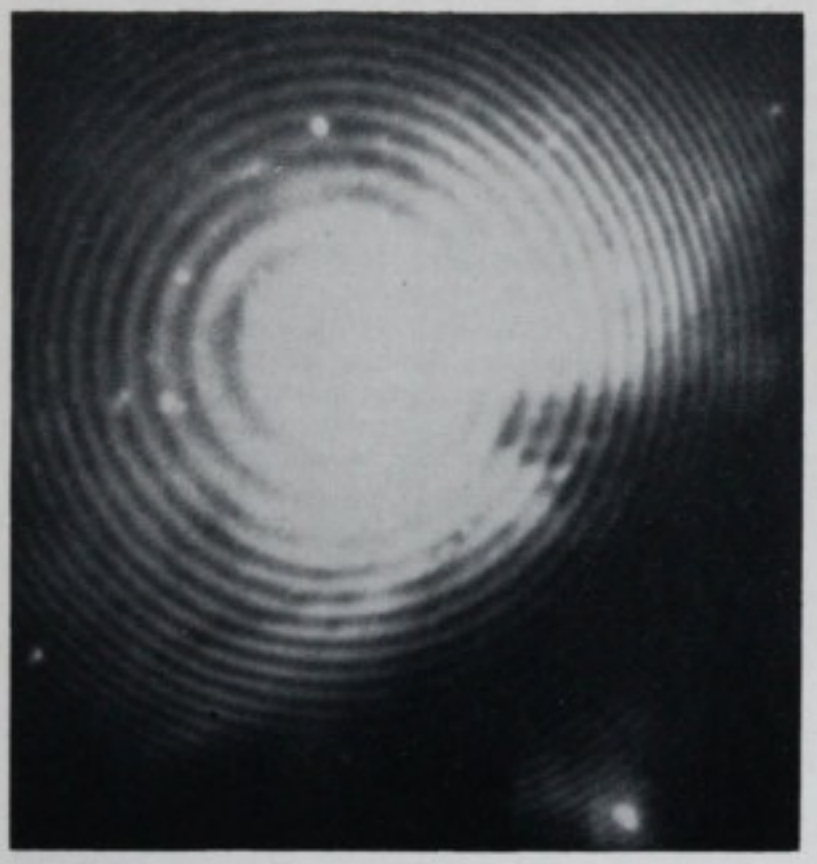
Hence, the wave length of H-alpha in this nebula is not the same as the wave length in the laboratory. From the formula, the small nebular rings correspond to decreased $\cos\theta$ and increased θ; hence the nebular wave length is greater than the laboratory one; there is a Doppler red shift, indicating recession of the nebula as a whole from us.



Compare the direct hydrogen-alpha photograph of the Horsehead nebula (left) with the Courtes interferometer picture at the right. The bright hydrogen circles are smaller than those in the superimposed strip from a laboratory source; from this difference the radial velocity of the nebula may be measured.

The displacement of the nebular circles relative to those of the laboratory hydrogen is about one third the separation of the circles, and this corresponds to about three angstroms or 150 kilometers per second. Hence the radial velocity of the Horsehead nebula is about +50 kilometers per second, uncorrected for the earth's motion.

the circles are not entirely concentric, but have peculiar deformations — sometimes toward the center, sometimes away from it. With these observations, Courtes concludes that the internal motions in nebular areas 10 by 10 seconds of arc are sometimes as large as 30 or 40 kilometers per second. He finds similar internal motions in the nebula near Omicron Cygni.



In this interferometer picture by Courtes, of the Great Nebula in Orion, thickenings on the rings show regions with large turbulent velocities; thinner parts mark relatively quiescent areas. Compare these observations with the early Lick measurements on page 93. All photographs on this and the facing page are from the Haute Provence Observatory.

Where the rings are thicker than corresponding rings in the laboratory source, internal motions of the nebula are indicated. Such a nebula may be agitated by small-scale turbulence or by large thermal motions, or both. The turbulent broadening of the nebular rings is especially pronounced in the Courtes photograph of the Great Nebula in Orion. The precision of the measurements of single points along individual rings is very satisfactory—about ±1 kilometer per second.

Incidentally, in the interferometer photographs the stars are recorded without rings or serious distortion, because they shine in continuous light. They can be used as reference points in the measurements.

Courtes has recently become interested in small-scale motions within nebulae. A careful inspection of the picture of the nebulosity near Gamma Cygni shows that

Of even greater interest are the velocity shifts that appear in and near dark interstellar clouds with bright emission edges. Courtes has studied this effect around the dark "elephant trunk" of M16 in Serpens. A large photograph of this object was published in the August, 1951, issue of *Sky and Telescope*. The two pictures here show the same portion of the nebula, with the rings oriented differently over the elephant trunk area.

The rings appear to be systematically broader where they overlie the bright regions adjacent to the dark material. As Courtes has remarked, a larger telescope will be needed to study these motions in detail.

The principal innovation in the Courtes interferometer is the use of multiple layers of zinc sulfide and cryolite for the inner reflecting surfaces. He uses interferometer plates, with five coatings, made by A. Couder, of Paris. The loss of light caused by absorption in the films is greatly reduced, and the circles are rendered exceedingly narrow and sharp.

Courtes does not state whether he has found it necessary to control his instrument thermostatically. D. Q. Wark, of Berkeley and the Lick Observatory, has used a similar interferometer for a study of the night sky, and has had to keep the temperature constant within 1/10 degree centigrade. Another point is whether the interferometer is sensitive to changes in zenith distance of the object under observation. Undoubtedly such questions will be answered when the entire work is published.

The interferometer method in its modern form is evidently going to be a powerful and versatile means of investigating nebulae. Meanwhile, the results obtained by Courtes have enabled him to make a new start with the statistical problem of von Weizsaecker and von Hoerner. His preliminary measurements of the nebulosity near Lambda Orionis agree with the theoretical prediction that the difference in velocities at two points is proportional to the cube root of the distance between them. But for the Orion nebula the proportionality is more nearly $d^{0.6}$, a departure that may have something to do with the enormous optical thickness of that great cloud of glowing gas.

Right: The ring pattern of the nebulosity near Gamma Cygni shows marked distortions.

Below: In M16, the dark "elephant trunk" extends toward the left; near its edges the rings thicken, indicating strong turbulence.

A Provisional List of the Major Meteor Showers*

PETER M. MILLMAN, *Dominion Observatory, Ottawa*

IN COMPILING a list of the chief meteor showers of the year it is very difficult to know where to draw the line. There is no sharp division between the major and minor showers and in the accompanying list I have included twenty showers, the choice of this number being purely arbitrary and of no special significance.

The list is an attempt to compile useful information for the meteor observer. It makes no pretence at being complete, nor should the figures given in the various columns be considered as accurate final values. As far as possible a reasonable average has been taken from various recent publications dealing with these showers, more weight being given to photographic and radio recording methods than to the purely visual observations. Brackets indicate a doubtful or very tentative value.

In general the showers in this list are the best annual showers but the Aurigids were included chiefly because they are in a very lean portion of the year; and the Giacobinids and the Bielids, though generally absent during the average year, have produced remarkable displays in the past. In compiling the data, sources too numerous to list in detail have been consulted. These included the papers on photographic meteors from the Harvard Observatory, the radio observations made at the University of Manchester, and the visual results collected by C. P. Olivier and C. Hoffmeister. Use has also been made of the Canadian meteor observations, many of which have been published in the *Journal*. The individual columns of the table are explained below:

Column 1. The most generally accepted name for the shower.

Column 2. The longitude of the sun at maximum. This must be used to compute the exact time of maximum for any given year.

Column 3. This date may vary by one depending on the location of the observer and the relation of the year in question to leap year.

Column 4. Many of these radiant positions are averages of a fairly diffuse radiant area.

Column 5. Note that the daily motion in right ascension is given in minutes of right ascension, not arc. To convert to arc multiply by the cosine of the declination of the radiant.

Column 6. It is very difficult to list good relative hourly rates. These given here are only general averages and vary considerably from year to year. They are for an observer plotting and include the sporadic meteors which contribute an average hourly rate of approximately 7. The daytime rates are determined by radio methods and are given on an equivalent basis to the visual rates.

Column 7. This is not the extreme possible duration of the shower but a practical figure indicating a period over which a reasonable number of the shower meteors may be observed. The relative sharpness of the shower maximum may be judged from the duration.

Column 8. The radiant spread is the probable error of the deviations of the individual meteor trails from a point radiant.

Column 9. The best average of the actual velocities observed, both photographic and radio, is given.

Column 10. These comets move in very similar orbits to those of the meteors and are probably physically connected with them.

PROVISIONAL LIST OF THE MAJOR METEOR SHOWERS

Shower	At Shower Maximum: $\lambda\odot$	At Shower Maximum: Mean Evening Date	At Shower Maximum: Radiant (1950) α	At Shower Maximum: Radiant (1950) δ	Daily Motion of Radiant α	Daily Motion of Radiant δ	Equivalent Total Hourly Number of Meteors for Single Observer at Shower Maximum	Normal Duration (days)	Photographic Radiant Spread	Observed Geocentric Velocity (km./sec.)	Associated Comet
Quadrantids	282.7	Jan. 3	231°	+50°			35	1		41	
Aurigids	321	Feb. 9	75	+42			12	(5)			
Lyrids	31.5	Apr. 21	273	+34			12	2		48	
η Aquarids	44.3	May 4	336	0	+ 53′	+22′	12	10		(66)	Halley
o Cetids	59	May 20	30	− 3			15 (daytime)	10		37	
ζ Perseids	77.2	June 8	62	+24	+ 66	+27	30 (daytime)	15		29	
Arietids	77.2	June 8	44	+23	+ 42	+33	45 (daytime)	20		38	
Scorpio-Sagittarius	83	June 14	260	−26	+ 52		12	80			
Draconids	97	June 28	220	+58			12 (40 in 1916)	(5)			Pons-Winnecke
β Taurids	98	June 29	86	+18	+ 48	+24	35 (daytime)	10		31	
δ Aquarids	127	July 30	340	−15	+ 52	+12	20	15	0.°7	41	
Perseids	139.2	Aug. 11	46	+57	+ 81	+ 8	50	20	0.6	61	1862 III
Giacobinids	196.2	Oct. 9	262	+54	+126	− 6	(20,000 in 1933; 1,000 in 1946 ☾)	1	0.1	23	Giacobini-Zinner
Orionids	207.0	Oct. 20	95	+15	+ 74	+ 8	20	10		66	Halley
Taurids	218.0	Oct. 31	54	+17	+ 35	+ 8	12	30	0.9	30	Encke
Northern Arietids	230	Nov. 12	50	+22			12	(5)			
Bielids (I)	232.5	Nov. 14	24	+44			(5,000 to 10,000 in 1872, 1885)	1		(16)	Biela
Leonids	234.0	Nov. 16	152	+22	+ 42	−25	20(>10,000 in 1833; 1,000 in 1867 ☾)	5	0.2	72	1866 I
Geminids	261.1	Dec. 13	113	+32	+ 63	− 4	40	5	0.2	35	
Ursids	270.5	Dec. 22	207	+80			15	(1)			

*Reprinted with permission from the *Journal* of the Royal Astronomical Society of Canada, September-October, 1954.

TWO PROJECTION DEVICES

for the Morrison Planetarium

LEON E. SALANAVE, *Morrison Planetarium, California Academy of Sciences*

ACCESSORIES to produce special effects play an important part in modern planetarium demonstrations. At the Morrison Planetarium of the California Academy of Sciences in San Francisco, two new devices have been constructed by A. S. Getten, the designer of our planetarium projector *(Sky and Telescope,* December, 1952).

The first of these, pictured here and on the front cover, is a projection orrery that demonstrates by optical means the relative positions and motions of bodies in the solar system. The standard planetarium projector gives a strictly geocentric view of the sky; it was desired to supplement this by a projection system that would show a heliocentric picture, with the four inner planets circling the sun, and the moon revolving around the earth.

In the accompanying photograph, the large fixed projector in the center puts a pattern of four circles on the dome, representing the orbits of the four inner planets. This projector may be turned off and on independently of the others. The orbits are circular, with those of Venus and the earth concentric with the sun, while those of Mars and Mercury are off center. This arrangement is particularly useful for demonstrations of favorable and unfavorable oppositions of Mars. The orbit of the ruddy planet is 14 feet in diameter, and the others are smaller in proportion. As seen against the planetarium dome, the earth is a spot of light that moves in an orbit about nine feet in diameter, in a "year" of 15 seconds.

In order to avoid having the orbit of Mercury on an impossibly small scale, Jupiter, Saturn, and the outer planets have been omitted. It turns out in practice that this omission is advantageous, for audiences are always impressed by the fact that the 65-foot dome is not big enough to contain the orbit of Saturn on the scale of the others.

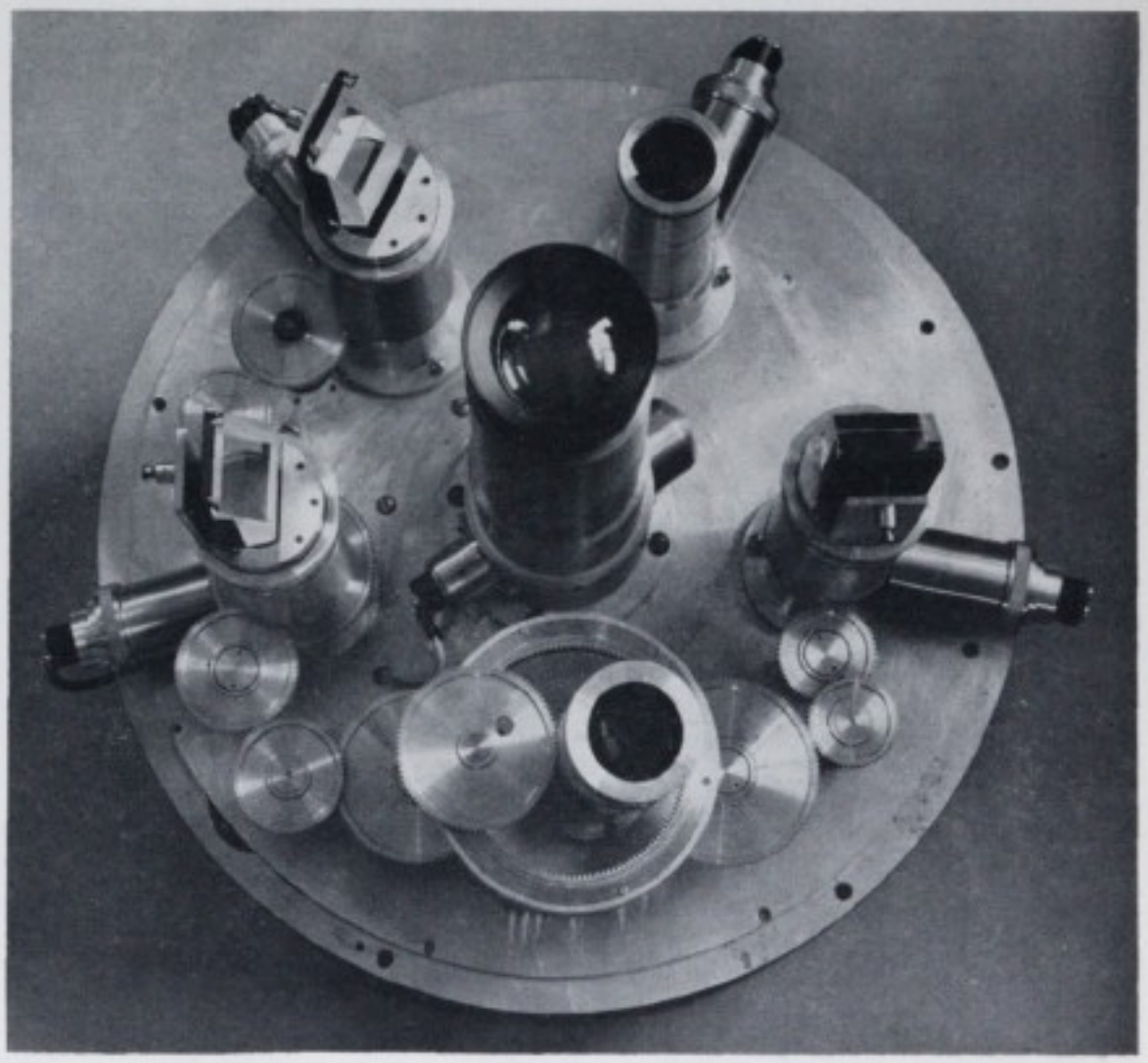
Each projector has its own lamp. The sun is produced by the small, fixed projector at top right in the picture. Starting at top left and going counterclockwise are the projectors of Mercury, Venus, Earth-Moon, and Mars. A small reversible motor under the base plate initiates the motion by rotating the Mercury projector, and the gear train gives proportionately slower motions to the other planets. The speed provides an earth year in 15 seconds. The accuracy of the gear ratios is such that Mars, for example, would lose one revolution while the earth revolved 56,271 times.

In front of the Mercury, Venus, and Mars projectors are dove prisms (see Gleanings for ATM's, November, 1954), tilted so that the respective images run around the sun at the proper distances as the prisms are individually rotated.

Mr. Getten's flair for realism is especially evident in his representation of the earth and moon for what they are—a double planet. The Earth-Moon projection plate contains two circular apertures; they are in sizes proportionate to the diameters but, of course, cannot be separated by the proper distance on the same scale. The lens tube is tilted to put the double image at the correct distance from the sun on the dome, accomplishing what is done with the prisms in the other cases. When the motor is turned on, the entire Earth-Moon projector is rotated and the annual motion is demonstrated. But at the same time the large internal gear causes the projection tube to rotate at the right speed for the moon's motion around the earth—or as the lecturer explains, for the earth and moon to revolve around their common center of mass.

The entire orrery is mounted within the base of the main planetarium instrument and is covered with a protective sheet of plate glass. Children, and grown-ups as well, like to look down into the beautiful network of gears and glass!

The Morrison Planetarium orrery is



The projection systems and gear trains for the sun and four inner planets are seen here from above, and may be compared with the picture on the front cover. Photographs by Elmer Moss, courtesy California Academy of Sciences.

not a new idea, for the Zeiss works have produced a heliocentric projector showing all the naked-eye planets and using the rotating prism idea. Mr. Getten arrived at the same solution independently; his design is more compact than its predecessor, and the moon is an additional feature. At the present time he is finishing a new orrery of this type for the Buhl Planetarium in Pittsburgh; a novel system of motion will make possible the entire projection by one lens instead of several.

Older planetarium projectors produce a moon that runs through its proper sequence of phases, but the lunar disk is blank white. To procure greater realism in the Morrison moon, Mr. Getten designed a new lunar projector. This utilizes a photograph of the full moon, so that the familiar pattern of gray and white markings appears on the lunar disk in the planetarium sky, and an occulting device simulates the moon's phases accurately. It was no simple matter to construct a suitable occulting mechanism, but the result is extremely realistic, even to the "man in the moon."

The photograph of the projector as a whole shows the main objectives of the projecting lens system; these objectives are horizontal, in the knurled rings. Above each is an inclined mirror with a counterweight; the mirrors produce the moon's movement of five degrees alternately north and south of the ecliptic (the sun's apparent path in the sky). Their periodic motion is produced by the flat arm between them, which is actuated from inside the projector by a cam mechanism. One of the housings for the two light sources is partially visible at the rear of the projector case. The gears at the top are for the phasing mechanism.

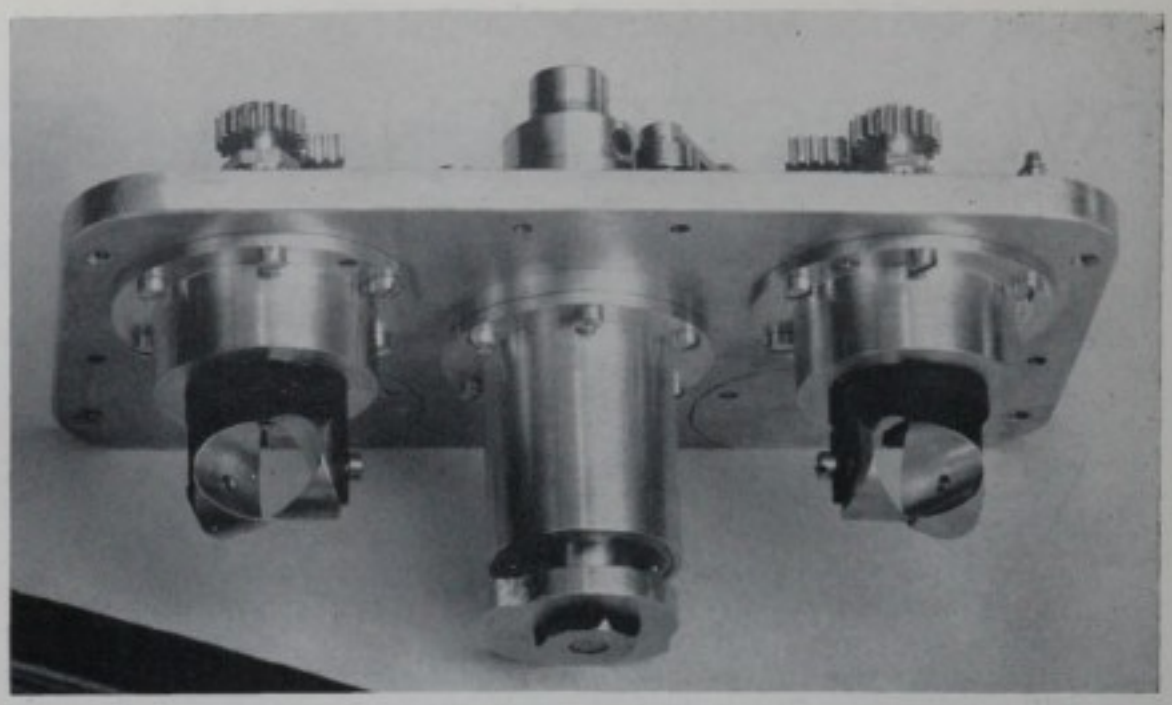
Light from each source passes through a condenser lens, the moon transparency, the phasing cups, thence to three mirrors that fold the light path into the confined space available. Each objective lens has a focal length of 13½ inches, but introduction of a negative lens raises the equivalent focus to 24 inches. This permits a convenient size (0.46 inch) for the transparencies, and projects a moon twice the normal size, one degree in diameter instead of half a degree. All planetarium suns and moons are projected larger than actual size; otherwise they look unrealistically small. The plane of the transparency is nearly half an inch from the occulting cups that produce the phases, but the depth of focus of the telephoto lens system is such that the projected terminator is still sharp. Photographs for the transparencies were supplied by Fred Chappell, of Lick Observatory.

To produce the proper sequence of phases, it was found necessary to have two pairs of cups, shown on the lower side of the plate pictured above. Their principle of operation can be simply explained if we ignore problems of optical inversion and the like and just look at the opening between the cups in each pair as if it were the moon itself. It is through these openings that the light projected through the transparency passes on its way to the sky.

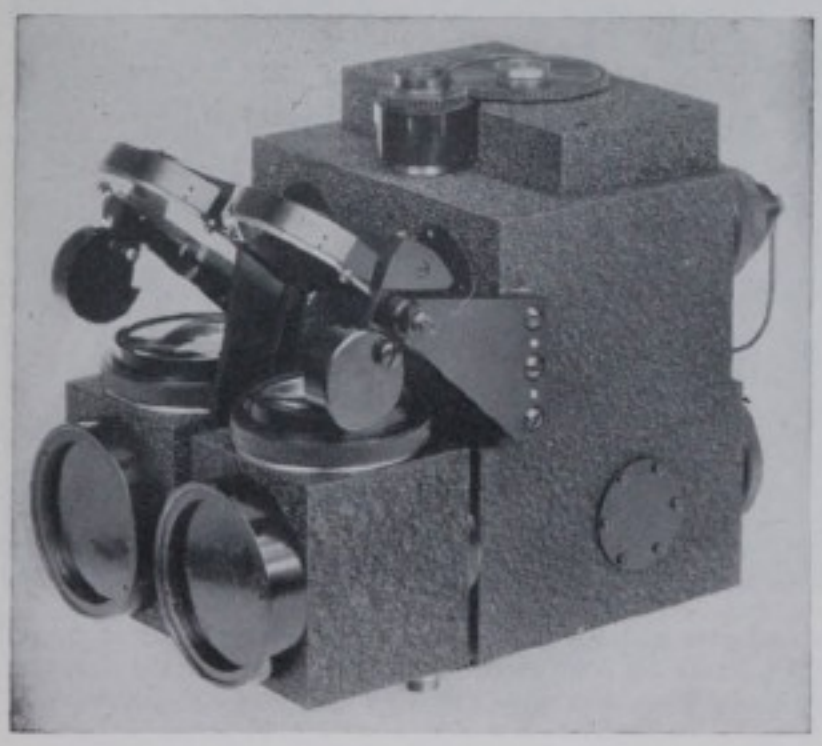
Suppose we are looking south in the sky, at the moon, and east is therefore to the left. The cups are set in position to produce first quarter; therefore, it is the pair on the left that is correctly oriented to occult the image of the full moon and produce a straight-line terminator with the round limb of the moon to the right of the terminator (toward the west). Now, as the lunar month proceeds from first quarter to full, the left-hand cup of the left pair rotates one-eighth turn clockwise and gradually increases the illuminated disk. The other cup of the left pair is stationary, for the western limb of the moon is not changed during the waxing phases.

When full phase is attained, the left cup becomes stationary, while the other starts to turn counterclockwise. As the nearer edge moves to the left over the moon's image, a terminator is produced on the right (west), thus generating the waning phases. After one quarter of a turn the moon is completely blacked out —it is new moon.

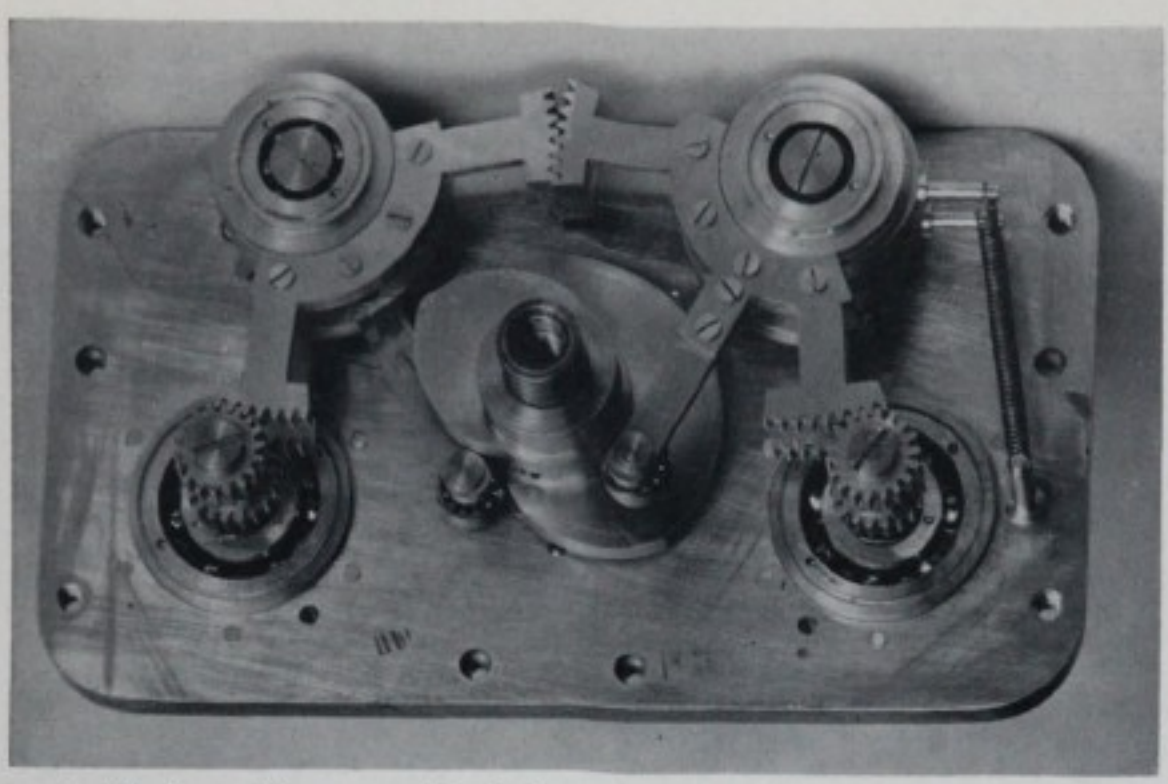
At this point, the central cam, at the end of the shaft between the pairs of cups, flips a microswitch that turns the left projector off as its mate on the right comes on. While the projector on the left was going through its cycle, the one on the right was undergoing a reciprocal motion; when its lamp is turned on its cups are also in position corresponding to the new phase. This projector now reproduces all the phases from new to full and back to new again, just as the left-hand projector had done before. Each



Designer Getten found that two pairs of occulting cups were needed to reproduce the phases of the moon with smoothness through entire lunations.



The Morrison lunar projector is here shown in a position to cast the moon's image horizontally to the left, from the mirrors that set at an angle above the main objectives. The occulting cups are inside the housing, in the upper right; their gear train is in the smaller, rectangular housing. The large gear on top of this housing drives the shaft carrying the cams shown in the picture on the opposite page.



In this view of the upper side of the plate carrying the occulting mechanism, the cams and gears are set to orient the cups as in the picture opposite.

projector takes over on alternate synodic months as long as the planetarium is in annual-motion drive.

The two pairs of cups permit switching from one transparency to the other at new moon. If there were only one cup on each transparency, the changeover would have to be made at full moon, and the images would jump because of slight differences in projection-lamp brightness and positioning. A single transparency and cup cannot continually produce the proper succession of phases.

A cup rotates only when its gear train on the other side of the plate is being governed by the spiral portion of its cam. There are two sets of gears and cams, as shown in the photograph of this mechanism. The upper (or outermost) gears and cams operate the inner cups, both left and right; the lower set operates the outer cups. Each cam has a circular radius for 180 degrees, and when its rider is on the circular portion, the cups it controls remain stationary. The main shaft in the center turns the cams clockwise continually. The setting of the cams in the picture corresponds to that for first quarter in the photograph of the occulting cups. The lower rider is starting to move away from the center of its cam, turning the most left-hand cup to produce the waxing phases between first quarter and full moon.

Planetarium Notes

(Most planetariums give group and special showings by appointment.)

BALTIMORE: *Davis Planetarium.* Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., Mulberry 2370.

SCHEDULE: 3:45 p.m. Monday and Friday (Sept.-June); Thursday, 7:15, 7:45, 9:00 p.m. Admission free. Spitz projector. Director, Paul S. Watson.

BUFFALO: *Buffalo Museum of Science Planetarium.* Humboldt Parkway, Buffalo, N. Y., GR-4100.

SCHEDULE: Sunday, 2:00 to 4:30 p.m. Admission free. Spitz projector.

CHAPEL HILL: *Morehead Planetarium,* Univ. of North Carolina, Chapel Hill, N.C.

SCHEDULE: Daily at 8:30 p.m.; also 11 a.m. and 3 p.m. Saturdays, 3 and 4 p.m. Sundays. Zeiss projector. Manager, A. F. Jenzano.

CHARLESTON, W. VA.: *Hillis Townsend Planetarium.* Public Library Building, Charleston, W. Va.

SCHEDULE: Saturday, 11:15 a.m. Admission free. Spitz projector. Director, Louise L. Morlang.

CHEROKEE, IA.: *Sanford Museum Planetarium.* Sanford Museum, 117 E. Willow St., Cherokee, Ia.

SCHEDULE: Monday, 8 p.m. (except August). Admission free. Spitz projector. Director, W. D. Frankforter.

CHICAGO: *Adler Planetarium.* 900 E. Achsah Bond Drive, Chicago 5, Ill., Wabash 2-1428.

SCHEDULE: Mondays through Saturdays, 11 a.m. and 3 p.m.; Tuesdays and Fridays, 8 p.m.; Sundays, 2:00 and 3:30 p.m. Zeiss projector. Director, Wagner Schlesinger.

INDIANAPOLIS: *Holcomb Planetarium.* Butler University, Indianapolis 7, Ind.

SCHEDULE: Wednesday, 3:30 p.m.; Saturday, 3:30, 8, and 9 p.m.; Sunday, 3:30, 4:30, 8, and 9 p.m. Spitz projector. Director, Harry E. Crull.

KANSAS CITY: *Kansas City Museum Planetarium.* 3218 Gladstone Blvd., Kansas City 23, Mo., Humboldt 8000.

SCHEDULE: Saturday, 3:00 p.m.; 2nd and 3rd Sundays, 3:00 and 4:30 p. m. Spitz projector. Director, Kenneth W. Prescott.

LOS ANGELES: *Griffith Observatory and Planetarium.* Griffith Park, P. O. Box 27787, Los Feliz Station, Los Angeles 27, Calif., Normandy 4-1191.

SCHEDULE: Wednesday, Thursday, and Friday at 8:30 p.m.; Saturday and Sunday at 3 and 8:30 p.m.; extra show on Sunday at 4:15 p.m. Zeiss projector. Director, Dinsmore Alter.

MINNEAPOLIS: *Science Museum.* Minneapolis Public Library, 1001 Hennepin Ave., Minneapolis 3, Minn.

SCHEDULE: Tuesday, 7:30 p.m.; Saturday, 10 a.m. and 2 p.m. Admission free. Spitz projector. Curator of education, Maxine L. Begin.

NASHVILLE: *Sudekum Planetarium.* Children's Museum, 724 2nd Ave. S., Nashville 10, Tenn., 42-1858.

SCHEDULE: Sunday, 2:45, 3:30, 4:15. Spitz projector. Associate curator of education, Burton Ingram.

NEWARK: *Newark Museum Planetarium.* 49 Washington St., Newark 1, N. J., Mitchell 2-0011.

SCHEDULE: Saturday and Sunday, 2:30 and 3:30 p.m. Admission free. Spitz projector. In charge, Ray Stein.

NEW YORK CITY: *American Museum—Hayden Planetarium.* 81st St. and Central Park West, New York 24, N. Y., Trafalgar 3-1300.

SCHEDULE: Mondays through Fridays, 2, 3:30, and 8:30 p.m.; Saturdays, 11 a.m., 1, 2, 3, 4, 5, and 8:30 p.m.; Sundays and holidays, 1, 2, 3, 4, 5, and 8:30 p.m.; Mondays, Wednesdays, Thursdays and Fridays, 11 a.m., for school groups. Zeiss projector. General manager, J. M. Chamberlain.

PHILADELPHIA: *Fels Planetarium.* Franklin Institute, 20th St. at Benjamin Franklin Parkway. Philadelphia 3, Pa., Locust 4-3600.

SCHEDULE: Tuesdays through Sundays, 3 p. m.; Saturdays, 11 a.m.; Saturdays, Sundays, and holidays, 2 p.m.; Wednesdays, Fridays, and Saturdays, 8:30 p.m. Zeiss projector. Director, I. M. Levitt.

PITTSBURGH: *Buhl Planetarium and Institute of Popular Science.* Federal and West Ohio Sts., Pittsburgh 12, Pa., Fairfax 1-4300.

SCHEDULE: Mondays through Saturdays, 2:15 and 8:30 p.m.; Sundays and holidays, 2:15, 4:15 and 8:30 p.m. Zeiss projector. Director, Arthur L. Draper.

PORTLAND, ORE.: *Oregon Museum of Science and Industry Planetarium.* 908 N.E. Hassalo St., Portland 12, Ore., East 3807.

SCHEDULE: Saturday and Sunday, 3:00 p.m. Spitz projector. Director, Stanley H. Shirk.

PROVIDENCE: *Roger Williams Planetarium.* Roger Williams Park Museum, Providence 5, R. I., Williams 1-5640.

SCHEDULE: Saturdays, Sundays, and holidays, 3 and 4 p.m. Admission free. Spitz projector. Director, Maribelle Cormack.

SAN FRANCISCO: *Morrison Planetarium.* California Academy of Sciences, Golden Gate Park, San Francisco 18, Calif., Bayview 1-5100.

SCHEDULE: Daily (except Monday and Tuesday) at 3:30 and 8:15 p.m.; also at 2 p.m. on Saturdays, Sundays, and holidays. Academy projector. Curator, George W. Bunton.

SPRINGFIELD, MASS.: *Seymour Planetarium.* Museum of Natural History, Springfield 5, Mass.

SCHEDULE: Tuesdays, Thursdays, and Saturdays at 3 p.m.; Tuesday evenings at 8:30 p.m.; special star stories for children on Saturdays at 2 p.m. Admission free. Korkosz projector. Director, F. Korkosz.

STAMFORD: *Stamford Museum Planetarium.* Courtland Park, Stamford, Conn.

SCHEDULE: Sunday at 4:00 p.m. Admission free. Spitz projector. Director, Ernest T. Luhde.

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BOOKS FOR AMATEURS—continued

THIS is the third and last of our series of selected books. In September, books for children and beginners were discussed; in November, we listed intermediate books. Here are advanced and specialized books and charts grouped into three sections.

THE SOLAR SYSTEM

The Face of the Moon, Ralph B. Baldwin. University of Chicago Press, Chicago, 1949, $5.00. A thorough study of the moon's surface features is coupled with information on the characteristics of explosive craters, leading to a strong argument for the impact origin of the major lunar craters.

The Planet Mars, Gerard de Vaucouleurs (translated by Patrick A. Moore). The Macmillan Co., New York, 2nd edition, 1951, $2.50. A brief but systematic study of reliable data on the red planet. Arguments on both sides of controversial issues are presented.

The Aurorae, L. Harang. John Wiley and Sons, Inc., New York, 1951, $4.50. Contains descriptions of auroral forms, heights, periodicity, spectra, and theoretical discussions.

The Atmospheres of the Earth and Planets, Gerard P. Kuiper, editor. University of Chicago Press, Chicago, 2nd edition, 1952, $8.50 cloth, $5.50 paper. An up-to-date revision of a basic work written by meteorologists, high-altitude specialists, and astronomers, presenting analysis of recent discoveries in the study of planetary atmospheres.

The Nature of Light and Colour in the Open Air, M. Minnaert (translated by H. M. Kremer-Priest and K. E. Brian Jay). Dover Publications, Inc., New York, 1954, $3.95 cloth, $1.95 paper. This book tells what to look for and how to observe phenomena we usually take for granted or fail to notice—the stages in twilight, colors in a lunar eclipse, the Milky Way, the zodiacal light, and so on.

Eclipses of the Sun, S. A. Mitchell. Columbia University Press, New York, 5th edition, 1951, $8.50. Contains facts of value to the beginner and advanced student—eclipse history, prediction, modern eclipse observations, and the technical aspects of eclipse research and the solar atmosphere.

A Guide to the Moon, Patrick Moore. W. W. Norton and Co., Inc., New York, 1953, $3.95. A popular, authoritative study in many areas of lunar research—theories of the origin of the earth-moon system and of lunar surface features, which the author believes was largely molded by igneous activity.

A Guide to the Planets, Patrick Moore. W. W. Norton and Co., Inc., New York, 1954, $4.95. A description of the solar system from theories of its origin to our present knowledge of each planet's characteristics. A section is devoted to observers' problems and amateur astronomy.

Out of the Sky: An Introduction to Meteorites, H. H. Nininger. Alan Swallow, Denver, 1952, $5.00. This book fills a need for up-to-date information on meteors and meteorites, and it outlines theories for the origin of meteorites.

Comets and Meteor Streams, J. G. Porter. John Wiley and Sons, Inc., New York, 1952, $5.25. Presents general background, mathematical procedures for computing the orbit of a comet, statistics of cometary orbits, meteor streams and velocities, and the interrelation of comets and meteor streams.

Astronomy—I: The Solar System, H. N. Russell, R. S. Dugan, and J. Q. Stewart. Ginn and Co., New York, revised edition, 1945, $5.50. Generally known as the basic text in astronomy, this book provides an excellent survey of the solar system, beginning with chapters on astronomical instruments and practical astronomy. The second volume is listed in the next section.

The Green and Red Planet, Hubertus Strughold. University of New Mexico Press, Albuquerque, 1953, $4.00. A brief discussion of Martian characteristics and atmosphere written by a biologist. He considers the ability of living organisms to survive under existing known conditions on Mars.

The Planets: Their Origin and Development, Harold C. Urey. Yale University Press, New Haven, 1952, $5.00. Written by a well-known physical chemist, this work presents newly developed theories of the origin of the solar system. The book may be understood by anyone with basic astronomical background and some chemical training.

Our Moon, H. Percy Wilkins. Frederick Muller, Ltd., London, 1954, 12s 6d. A new descriptive account of the surface of the moon in popular presentation. Descriptions of individual craters are given in appendices. The author is director of the lunar section of the British Astronomical Association.

ASTRONOMY AND ASTROPHYSICS

Astrophysics: A Topical Symposium, J. A. Hynek, editor. McGraw-Hill Book Co., Inc., New York, 1951, $12.00. A compilation by 15 specialists prepared for the "hypothetical graduate student." Covers spectroscopy of celestial bodies, physics of the solar system, binary and variable stars, and physics of interstellar matter.

Radio Astronomy, Bernard Lovell and J. A. Clegg. John Wiley and Sons, Inc., New York, 1952, $4.00. A readable, authoritative survey of the newest branch of astronomy which introduces the reader to radio aerials, detection of radio noise, and pulse radar techniques. Radio astronomy of meteors is discussed in detail, and brief reference is made to radio work on the aurora, the moon, and the planets. Studies of radio stars and galactic radio noise are described, with emphasis on work by English observers.

Physics of the Sun and Stars, W. H. McCrea. Longmans Green and Co., New York, 1950, $2.40. A brief, thorough treatment of the basics of astrophysics, utilizing mathematical formulae, but not burdened with their development.

Astronomy—II: Astrophysics and Stellar Astronomy, H. N. Russell, R. S. Dugan, and J. Q. Stewart. Ginn and Co., New York, 1938, $5.00. The second volume in this standard textbook. Devotes considerable space to stellar spectroscopy and all phases of the physics of stars and the galaxy. Recent advances in galactic theory, stellar evolution, and extragalactic discoveries are not, of course, reflected in this volume.

Stellar Evolution, Otto Struve. Princeton University Press, Princeton, 1950, $5.00. Presents known facts on luminosities, masses, dimensions, and spectra of the stars, and discusses the role of the interstellar medium and the problem of rotating stars and star shells. The author discusses close binaries and a theory of their probable evolution.

OBSERVING BOOKS AND STAR CHARTS

AAVSO Atlas, American Association of Variable Star Observers. Available from Richard Hamilton, Fox Hill Lane, Darien, Conn., $3.00. This consists of a set of 20 blueprints, unbound, each 12 by 15 inches, covering the whole sky to the 6th magnitude. Bright variables are marked. The epoch of the co-ordinates is 1900.

Beyer-Graff Star Atlas, M. Beyer and K. Graff. About $15.00. Available from Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y. Contains about 180,000 stars on 27 maps, to the 9th magnitude. Stars from the north pole to −23° declination are included. The scale is one degree to one centimeter, and the co-ordinate epoch is 1855.

Bonner Durchmusterung Charts and Catalogues, Bonn Observatory, West Germany. Revised 1951-1954; northern sky only, $62.50; southern sky only, $38.50; complete BD charts and catalogues, $100.00. Available from Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y. Standard charts of all stars to magnitude 9.5. The northern sky from the pole to the equator is contained in 40 22½-by-30-inch maps, totaling 324,000 stars. The southern sky, from the equator to −22° declination is contained in 24 18-by-22½-inch maps, each covering one hour in right ascension, totaling 133,000 stars. The coordinate epoch is 1855, but a nomogram allows conversion of star positions to later dates. The matching catalogues give the star positions, and are in book form, each 8½ by 6 inches.

New General Catalogue of Nebulae and Clusters of Stars (and Index Catalogue, Second Index Catalogue), J. L. E. Dreyer. Royal Astronomical Society, London, 1953. £3 10s. The standard catalogue for positions of nearly 15,000 of the brightest clusters and nebulae. This is a reprint from earlier works of 1888, 1895, and 1908.

Skyshooting, R. Newton Mayall and Margaret L. Mayall. Ronald Press Co., New York, 1949, $4.00. A good book for the amateur who wishes to photograph the heavens with or without a telescope. Describes mountings and cameras and telescopes best suited for celestial photography.

A Star Atlas and Reference Handbook, Arthur P. Norton and J. Gall Inglis. Gall and Inglis, Edinburgh, 11th edition, 1950, $5.25. Available from Eastern Science Supply Co., 7 High St., Boston, Mass. In a book 9 by 11½ inches, there are large charts covering the entire sky to magnitude 6.5, showing over 9,000 stars, also nebulae, clusters, and lists of double stars and other objects for amateur observers. The epoch of the 11th edition is 1950.

(Continued on page 120)

NEWS NOTES

By Dorrit Hoffleit

"STAR FALLS ON ALABAMA"

On November 30th, an exploding meteor illuminated the midday sky over Georgia, Alabama, and Mississippi. According to press accounts, it was seen at Atlanta, Montgomery, and Greenville, and it exploded with detonations like thunder.

A meteorite fragment, weighing about nine pounds, penetrated the home of Mrs. Hewlett Hodges in Sylacauga, Ala., about 40 miles south of Birmingham. She was asleep in the living room when the crash woke her; she found the meteorite on the floor and her hip and hand bruised. It is possible that the meteorite grazed her as it fell.

The celestial visitor created quite a stir. Maxwell Air Force Base sent scores of planes searching for possible plane wreckage. The Air Force sent a helicopter to Sylacauga, and the meteorite was taken for examination to Wright-Patterson Field at Dayton, Ohio.

MARTIAN QBSERVATIONS FROM A BALLOON

Audouin Dollfus made a balloon ascent, with his father Charles Dollfus as pilot, from the observatory at Meudon, France, on the night of May 29-30, 1954, for the purpose of determining the amount of water vapor in the atmosphere of Mars. Previous attempts to observe Martian water vapor from the earth's surface have been seriously handicapped by the intervening abundance of water vapor in our own atmosphere.

Keeping the planet in the field of an 11-inch f/1 spherical mirror by hand guiding, Dollfus made photoelectric observations through a polarizing filter transmitting a band 130 angstroms wide, centered on the water-vapor absorption band at 8250 angstroms. Measurements were made for three hours as the balloon attained a maximum altitude of 7,000 meters.

Dollfus believes that the amount of water vapor in the atmosphere of Mars is comparable to that within our own atmosphere above 6,500 meters — only a hundredth the amount above sea level. However, the light from Mars that passed through the filter was too small for accurate measurement. Dollfus finds his method proved feasible, but states that it should be repeated with more sensitive photoelectric equipment.

POLISH ASTRONOMER DIES

Tadeuse Banachiewicz, director of Krakow Observatory in Poland until his death on November 17, 1954, at the age of 72, was a mathematical astronomer of marked ingenuity. He was the founder, in 1925, and editor of the journal *Acta Astronomica*, to which he contributed profusely. From 1932 to 1938 he was a vice-president of the International Astronomical Union. He was a member of its commissions on minor planets, variable stars, and time determination, and was president of the commission on the motion and figure of the moon. The libration of the moon was a field in which he was an outstanding authority.

But Dr. Banachiewicz will probably be best remembered for his invention of cracovians, a mathematical form which for more than 20 years he advocated widely and unremittingly as shortening and simplifying many astronomical calculations.

NOVA HERCULIS AS AN ECLIPSING BINARY

Many readers will recall the nova in Hercules that brightened to the 2nd magnitude in December, 1934, which now has faded to magnitude 14. This star is remarkable, and unique among known novae, for Dr. Merle F. Walker, now of Yerkes Observatory, has found that it appears to be a double star so oriented that one star regularly eclipses the other.

During photoelectric observations with the 100-inch Mount Wilson telescope, to detect rapid light changes in several old novae, Dr. Walker found that DQ Herculis is an Algol-type eclipsing variable with a period of only four hours 39 minutes. The primary eclipse lasts about one hour and is partial. The light range is 0.9 magnitude in ultraviolet light, 1.1 in blue, and 1.3 in yellow light. The existence of a secondary minimum is still somewhat in doubt.

The light curve appears similar to that of UX Ursae Majoris, whose period of four hours 43 minutes had been the shortest known previously for an eclipsing binary. Both variables show very rapid intrinsic variations and at times asymmetric light curves. In both cases the component stars must be very small and dense.

Was Nova Herculis originally a double star or did it become one by fission during the nova outburst 20 years ago? Observations by O. Morgenroth on Sonneberg Observatory plates taken between August 1, 1930, and November 3, 1934—before the outburst—indicated no perceptible variation of a 15th-magnitude star in the position of the nova. Harvard plates between 1894 and 1934, examined by Miss Constance Boyd in 1934, show a possible variation of only a few tenths of a magnitude.

Dr. Walker's observations are reported in the *Publications* of the Astronomical Society of the Pacific for October, 1954.

"ASTRONAUTICS"

The first issue of the quarterly journal, *Astronautics*, of the newly founded American Astronautical Society has recently appeared. In this issue, emphasis is given to the human aspects of space travel. The leading article, "Training for Space," by J. Gordon Vaeth, Office of Naval Research, discusses the often overlooked necessity for a thoroughly trained space crew, and outlines steps for such training under simulated flight conditions.

Inquiries about the magazine and the society may be addressed to the American Astronautical Society, Inc., 516 Fifth Ave., New York 36, N. Y.

IN THE CURRENT JOURNALS

THE CURVATURE OF SPACE, by P. Le Corbeiller, *Scientific American*, November, 1954. "It needed only two steps, one taken by Riemann and the other by Einstein, to carry us from Gauss's equation [1827] into the land of general relativity."

THE SOLAR OBSERVATORIES OF MEGALITHIC MAN, by A. Thom, *Journal*, British Astronomical Association, October, 1954. "Thus the megalithic remains in our own country [Great Britain] carry a record of the obliquity [of the ecliptic] which is much earlier and is probably much more accurate than the earliest recorded Chinese value."

TRAVEL PLANS TO A SEVEN-MINUTE ECLIPSE

(Continued from page 87)

Service would require final payment of the travel costs by May 1st. For cancellations before this date, the $50 would be returnable.

Weather records from the Manila Observatory show poor prospects for ground observations: June is hot and humid, with an average cloudiness of 70 per cent. It is possible that observing will be feasible only from the air, and plans for a standby plane to fly as high as 20,000 feet will be made, the cost divided among the participants. If enough persons apply, it may be possible to charter a Stratocruiser for the entire tour at reduced cost, and this plane would then be available during the eclipse.

For this and other reasons, it is essential to find out within the month of January approximately how many persons intend to participate. Expressions of your interest or of your intention to take part should be sent to *Sky and Telescope* as soon as possible. Also, you should communicate with the Globe Travel Service, Senator Hotel, Salem, Ore., for details of the itinerary, costs, and aid in planning travel beginning at your home town, possibly with a saving in over-all expenses.

HERE AND THERE WITH AMATEURS

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

State	*City*	*Organization*	*Time*	*Meeting Place*	*Communicate With*
ALABAMA	Birmingham	*Shades Valley A.C.	7:30, 3rd Tue.	Homewood Pub. Libr.	John C. Heslip, 1500 Oxmoor Rd.
ARIZONA	Phoenix	*Phoenix Obs. Ass'n	8:00, 2nd, 4th Mon.	Phoenix Coll., homes	A. H. Hoff, 1102 W. Thomas Rd.
	Tucson	*Tucson A.A.	7:30, 1st Wed.	Steward Obs.	Mrs. Kathryn Burch, 216 Busch Pl.
ARKANSAS	Little Rock	†*Arkansas A.A.C.	7:30, 3rd Mon.	Fair Pk. Golf Club	C. P. Kulp, 1615 Fair Park Blvd.
CALIFORNIA	Bakersfield	Bakersfield A.A.	7:30, 1st Wed.	Private homes	Gary W. Schmidt, 1700 Quincy St.
	Fresno	*Central Val. Ast'mers	7:45, 2nd Mon.	Fresno Coll., homes	Elizabeth Dean, 3534 N. Callisch (3)
	Kentfield	*Marin Am. Ast.	8:00, 1st Mon.	Coll. of Marin	Rita Treleven, Box 102, Fairfax
	Long Beach	†*Excelsior Tel. Club	7:30, 3rd Fri.	Private homes	T. R. Cave, Jr., 265 Roswell Ave. (3)
	Los Angeles	L.A.A.S.	7:45, 2nd Tue.	Griffith Obs.	G. Carroll, 7114 Summitrose St., Tujunga
	Oakland	*Eastbay A.S.	8:00, 1st Sat.	Chabot Obs.	Mrs. David Roberts, 551 El Dorado Ave.(11)
	Palo Alto	*Peninsula A.S.	8:00, 1st Fri.	Community Center	H. W. Milner, 350 Tennyson Ave.
	Redlands	*Redlands A.S.	8:00, 4th Thu.	Univ. of Redlands	Miss R. Schweikert, 111 Prospect Dr.
	Sacramento	*Sac. Val. A.S.	8:00, 2nd Thu.	Calif. Jr. Mus.	Mrs. E. Champ, 3816 Sacramento Blvd. (17)
	San Diego	Ast. Soc. of S.D.	7:30, 1st Wed.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	A.T.M. Ast. Club	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	Al Nelson, 3121 Hawthorn St.
	San Francisco	*S.F. Am. Ast'mers	8:00, 1st Wed.	Randall Jr. Museum	H. A. Wallace, 2925-A Jackson St.
	Stockton	*Stockton A.S.	8:00, 2nd Mon.	Stockton Coll., C-3	W. D. Purdy, 325 E. Kettleman Lane, Lodi
	Whittier	Whittier A.S.	7:00, Alt. Sun.	Private homes	Gary A. McCue, 7855 S. Euclid Ave.
COLORADO	Boulder	*Boulder A.S.	7:30, 2nd Wed.	Semmers-Bausch Obs.	Vernon Goerke, 3045 Bluff St., HI2-3447
	Denver	*Denver A.S.	8:00, 2nd, 4th Fri.	Chamberlin Obs.	Ralph Asbury, 340 Cherokee, SP7-2012
	Pueblo	†*Pueblo A.S.	7:30, 1st Mon.	2421 2nd Ave.	Mrs. Marjorie Struthers, 2329 E. Routt Ave.
CONNECTICUT	Middletown	†*Central Conn. A.A.	8:00, 1st Tue.	Van Vleck Obs.	W. Fellows, RFD No. 1, Hill St., Glastonbury
	New Haven	†A.S. of New Haven	8:00, 4th Sat.	Sterling Tower	Florence Welter, 77 Spring Rd., N'th Haven
	So. Norwalk	†Fairfield Co. A.S.	8:00, 3rd Fri.	Stamford Museum	Goldie L. Grantham, 58 Bouton St.
DIST. COL.	Washington	†*Nat'l. Cap. Ast'mers	8:00, 1st Sat.	Comm. Dept. Audit.	Miss E. Goerner, 20 Plattsburg Ct.N.W.(16)
FLORIDA	Daytona Beach	D. B. Stargazers	8:00, Alt. Mon.	105 N. Halifax Ave.	Wm. T. Thomas, 105 N. Halifax
	Jacksonville	†*J.A.A.C.	8:30, 1st, 3rd Mon.	Private homes	E. L. Rowland, Jr., 225 W. Ashley St. (2)
	Key West	†Key West A.C.	8:00, 3rd Thu.	Private homes	J. M. Martin, 1605 United St.
	Miami	†*South'n Cross A.S.	8:15, 3rd Mon.	Central School	A. P. Smith, Jr., 426 S. W. 26 Rd.
	Miami Springs	†*Gulfstream A.A.	8:00, 4th Wed.	400 SW 2nd Ave., Miami	L. G. Pardue, 641 Falcon, 88-5434
	Patrick AFB	*Banana River A.S.	8:00, 2nd Wed.	PIO, Bldg. T-580	Helen DePaolo, 1353 EverzladeDr.,EauGallie
	Pensacola	†Pensacola A.A.C.	8:00, Wed.	Private homes	John Aguilar, 1203 N. 9 Ave.
	St. Petersburg	†St. P'burg A.A.C.	7:30, 4th Tue.	City Museum Audit.	Dr. R. E. Angell, 233 5th Ave. N.
GEORGIA	Atlanta	†*Atlanta A.C.	8:00, 3rd Fri.	Agnes Scott College	W. H. Close, 225 Forkner Dr., Decatur
	Columbus	*Columbus A.A.C.	7:30, 2nd Fri.	Bradley Mem. Lib.	Marcia Thompson, 1306-16 Ave.
HAWAII	Honolulu	Hawaii A.S.	7:30, 3rd Tue.	McKinley H.S., Cot. 36	R. Terry, 99-531 Kaholi Pl., Aiea, 463762
IDAHO	Idaho Falls	*Idaho A.A.	8:00, 1st Sat.	475 J St.	Mrs. O. W. Hendrickson, 475 J St.
ILLINOIS	Chicago	†*Burnham A.S.	3:00, 2nd Sun.	Adler Planetarium	J. A. Anderer, 7929 S. Loomis Blvd. (20)
	Galesburg	†*G'burg Am. Ast'mers	7:30, 1st Wed.	Knox Obs.	Harlowe L. Herrin, 1246 N. Morton Ave.
	Geneva	*Fox Valley A.S.	8:00, 2nd Tue.	Geneva City Hall	Joseph Zoda, 420 Fellows St., St. Charles
	Moline	†*Popular A.C.	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3201 Coaltown Rd.
	Peoria	Ast. Sec., Acad. Sci.	8:00, 1st Wed.	Glen Oak Pk. Pav'n.	R. P. Van Zandt, 156 N. Eleanor Pl. (5)
INDIANA	Indianapolis	†*Indiana A.S.	2:15, 1st Sun.	Riley Library	W. E. Wilkins, 6124DeweyAve.(19),IR-5946
	South Bend	*St. Jos. Valley Ast.	7:30, 1st Thu.	YMCA	Bruce A. Lovell, RR 6, Box 61A
KANSAS	Wichita	†*Wichita A.S.	8:00, 1st Wed.	Friends Univ.	S. S. Whitehead, 425 N. Lorraine(8),62-6642
KENTUCKY	Louisville	†L'ville A.S.	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 207 Sage Rd. (7)
	Louisville	†*L'ville Jr. A.S.	7:30, 3rd Tue.	Private homes	Carol Lipphard, 2421 Calvin Ave. (6)
LOUISIANA	Gretna	Gretna A.S.	7:00, 2nd, 4th Sat.	209 Newton St.	John A. Gunther, 209 NewtonSt.,Algiers2710
	Lake Charles	†*Lake Charles A.A.C.	7:45, 2nd Tue.	H.S. Chem. Lab.	Norman G. Lore, 532 Alamo St.
	New Orleans	A.S. of N.O.	Irregular	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MASSACHUSETTS	Cambridge	†*Bond A.C.	8:00, 1st Thu.	Harvard Obs.	R. Smith, 519 Quincy Shore Dr.,No.Quincy71
	Cambridge	†*A.T.M.s of Boston	8:00, 2nd Thu.	Harvard Obs.	W. Knight, 75 S. Crescent Cir., Brighton 35
	Springfield	†*S'field Stars	8:00, 2nd Wed.	Private homes	J. Welch, 107 Low'r B'verly Hills, W S'field
	Worcester	†*Aldrich A.S.	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	W. C. Lovell, 24 Courtland (2), 3-1559
MICHIGAN	Battle Creek	†B. C. A.A.C.	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett Ave.
	Detroit	†*Detroit A.S.	3:30, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Jackson	*Jackson A.S.	7:30, 2nd Thu.	Public Library	Allen Bell, 1103 Hamlin Pl.
	Kalamazoo	†Kalamazoo A.A.A.	8:00, Sat.	Private homes	Edgar Pashby, 420 Evelyn Ave.
	Lansing	†*Lansing A.A.	8:00, Sat.	Private homes	R. Elliott, 434 Cowley Ave., E. Lansing
	Pontiac	†*Pon.-N.W. Det. A.A.	7:30, 3rd Thu.	Lincoln Jr. H.S.	G. Carhart, 40 Hadsell Dr., FE 2-9980
MINNESOTA	Minneapolis	*J.A.C. of M'polis	4:15, 2nd, 4th Wed.	Public Library	E. Haskins, 3732 Garfield Ave. S., RE-0201
	Minneapolis	M'polis A.C.	7:30, 1st Wed.	Public Library	Maxine Begin, Sci. Mus., M'polis. Pub. Lib.
	St. Paul	†*St. Paul Tel. Club	7:30, 2nd, 4th Wed.	Macalester Coll.	John Fleischhacker, 3520 Edgerton St. (6)
MISSOURI	Fayette	†*Central Mo. A.A.	7:30, 3rd Sat.	Morrison Obs.	R. C. Mang, 816½ S. Mass., Sedalia
	Kansas City	†*A.C. of Kans. City	8:00, 4th Sat.	K.C. Museum	Mrs. Laura Kinsey, 4604 Jefferson (12)
	St. Louis	†*St. Louis A.A.S.	8:00, 3rd Fri.	Inst. of Tech., St. L. U.	S. O'Byrne, 501 Glen Rd., Webster Groves19
NEVADA	Reno	A.S. of Nev.	8:00, 4th Thu.	Univ. of Nevada	Dr. Vernon Frazier, University of Nevada
NEW JERSEY	Caldwell	West Essex A.S.	8:30, 2nd Mon.	Caldwell Mun. Bldg.	Donald C. Smith, 19 Francisco Ave.
	Cranford	†*A.A.S. of Union Co.	8:00, 4th Fri.	Plainfield YWCA	Mrs. W. N. Lurcott, 220 High St.
	Rutherford	A.S. of Rutherford	8:00, 1st Thu.	YMCA	Mrs. Helen Waite, 11 Bryan Ct.
	Teaneck	†Bergen Co. A.S.	8:30, 2nd Wed.	Obs., 107 Cranford Pl.	J. M. Stofan, 332 Herrick
NEW MEXICO	Las Cruces	†*A.S. of L.C.	7:30, 1st or 2nd Sat.	Private homes	W. H. Haas, 1203 N. Alameda Blvd.
	Roswell	*Pecos Val. S.&T.C.	7:30, 2nd Fri.	Cham. of Comm.	Dr. R. R. Boice, Rt. 2, Box 163A
NEW YORK	Brooklyn	†Junior A.C.	8:00, 3rd Fri.	Bkl'n Public Library	Jr. A. C., Pub. Lib., Grand Army Plaza (38)
	Buffalo	†*Buffalo A.A.	7:30, 1st Wed.	Mus. of Science	Dr.F.S.Jones,83 Briarcliffe,Cheektowaga (25)
	Corning	Corning A.C.	8:00, 1st, 3rd Mon.	Corning Glass Center	W. R. Redmond, 3 E. 3rd St.
	Gloversville	†A.C. of Fulton Co.	6:30, Wed.	Private homes	Emmanuel Weil, 38 E. Blvd.
	New York	*A.A.A.	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, Hayden Plan., TR 3-1300
	Rochester	†Ast. Sec., Acad. Sci.	8:00, 1st Fri.	Rochester Museum	Louise M. Zeitler, 91 Hickory St. (20)
	Schenectady	†*S'tady A.C.	7:30, 3rd Mon.	Union Coll., C.E. Bldg.	C. E. Johnson, 102 State St.
	Troy	*Renss. Ap. Soc.	8:00, Fri.	R.P.I. Obs.	Dr. Robert Fleischer, R.P.I.
	Troy	*Troy A.C.	8:00, 4th Sat.	Private homes	P. Cenni, 2316 6th Ave.
	Utica	†*Utica Am. Ast'mers	7:30, 4th Tue.	Proctor Inst.	S. Wolczanski, 506 William St.
	Wantagh	Long Island A.S.	8:00, Sat.	Private homes	A. R. Luechinger, 2009 Seaford Ave., 1571
N. CAROLINA	Chapel Hill	†Chapel Hill A.C.	8:00, Alt. Wed.	Morehead Plan.	C. C. Tucker, Jr., Morehead Planetarium
	Charlotte	*Charlotte A.A.C.	8:00, Last Mon.	Myers Pk. H.S.	Mrs. L. W. Kelly, 1014 Kennilworth Ave.(3)
	Greensboro	†*Greensboro A.C.	8:00, Fri.	Woman's Coll., U.N.C.	Dr. A. D. Shaftesbury, 315 Tate St.
	Winston-Salem	†*Forsyth A.S.	7:30, Last Fri.	Private homes	Kenneth Shepherd, 1339 W. 4th St.
NORTH DAKOTA	Grand Forks	†*Red River A.C.	8:00, 2nd, 4th Mon.	City Hall	L. G. Peck, 2101 1st Ave. North
OHIO	Akron	*A.C. of Akron	8:00, Last Fri.	YMCA	Mrs. R. J. Couts, 878 Kennebec Ave. (5)
	Cincinnati	*Cin. A.A.	8:00, Various days	Cincinnati Obs.	John G. Weigel, 2481 Erie Ave. (8)
	Cincinnati	*Cin. A.S.	8:00, 3rd Fri.	Obs., Zion Rd., M. Hts.	Isolina Cartlidge, 5556 Raceview Ave. (11)
	Cleveland	Cleveland A.S.	8:00, Fri.	Warner & Swasey Obs.	Mrs. Helen Strohm, Warner & Swasey Obs.
	Columbus	*Columbus A.S.	8:00, 2nd Sat.	McMillin Obs.	Miss R. A. Charlton, 1361 E. 22 Ave. (11)
	Dayton	A.T.M.s of Dayton	Eve., 3rd Sat.	Private homes	F. E. Sutter, 5038 Lebanon Pike (9)

Amateur Astronomers

SEATTLE CONVENTION NOTES

THE 1955 GENERAL CONVENTION of the Astronomical League will be held in Seattle on July 1-5, 1955. Through the sponsorship of Dr. T. S. Jacobsen, of the department of astronomy, sessions will be at the University of Washington; the host group is the Seattle Amateur Astronomical Society.

The general chairman of the convention is Norman C. Dalke, 3640 Densmore Ave., Seattle. Papers to be presented should be sent to the program chairman, A. P. Patten, 4727 16th Ave. N. E., Seattle 5, Wash.

Rooms (with twin beds) and meals will be available on the campus, at the rate of $4.20 per day per person. Accommodations are available for men, women, and family groups. The registration fee is $1.00 until May 1st, and $1.50 thereafter. For registration and reservations on campus, send $5.20 (or $5.70 after May 1st) to: Office of Short Courses and Conferences, University of Washington, Seattle 5, Wash.

There will be plenty of exhibit space available, and a large number of exhibits are desired.

An excursion by bus and boat leaving from Seattle on July 4th is planned. After driving to Anacortes, bus and passengers will be ferried across to Victoria, B. C., for an overnight stay. There will be a visit to the Dominion Astrophysical Observatory. The return will be by boat and bus to Seattle via Vancouver, B. C., on July 5th. Because Monday, July 4th, is a holiday, it will be necessary to make early reservations for this trip. It is estimated that the trip and overnight lodging will be about $15.00 (not including meals). In order to facilitate planning of this excursion, we would greatly appreciate early notification of your intention to go. This should be sent to Robert J. Nicola, 4231 East 125 St., Seattle.

JAMES H. KARLE, president
Astronomical League

THIRD ANNIVERSARY REPORT

Three years ago last fall, a group of astronomy enthusiasts met to form what has become the Seattle Amateur Astronomical Society, which now has a current paid-up membership of 93. Soon after the club was formed, it acquired a 12¼-inch reflecting telescope made by one of the members, and the gift of a lease of land on which to build an observatory. Funds were raised the first year to build the foundations and walls, and additional money is now in the treasury to insure construction of the dome, for which plans have been drawn up.

In the past year we had an exhibit in the city-wide Do-It-Yourself hobby fair. Demonstrations of the Foucault pendulum and of mirror grinding were featured. A class in telescope making is currently being conducted, which will result in 13 new instruments.

The Seattle Amateur Astronomical Society is looking forward to welcoming the 1955 general convention of the Astronomical League in July.

L. D. CROWLEY
Secretary-treasurer
4727 16th Ave. N.E.
Seattle 5, Wash.

THIS MONTH'S MEETINGS

Brooklyn, N. Y.: Brooklyn Institute of Arts and Sciences, 8:15 p.m., Academy of Music. Jan. 7, Dr. Charles H. Smiley, Brown University, "Celestial Lights."

Cambridge, Mass.: Bond Astronomical Club, 8 p.m., Harvard College Observatory. Jan. 6, "Astronomy Up to Date."

Cleveland, Ohio: Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. Jan. 14, Dr. Serge A. Korff, New York University, "The Origin of Cosmic Rays."

Dallas, Tex.: Texas Astronomical Society, 8 p.m., Lone Star Gas Co. auditorium. Jan. 24, W. E. Daniel, "Observers from Outer Space."

Geneva, Ill.: Fox Valley Astronomical Society, 8 p.m., City Hall. Jan. 11, V. A. Carpenter, "Photoelectric Cells—Uses and Applications in Astronomy."

Minneapolis, Minn.: Junior Astronomy Club, 4:15 p.m., Public Library. Jan. 12, panel discussion, "Winter Skies." Jan. 26, Hub T. Sherman, "Popular Double Stars."

Minneapolis Astronomy Club, 7:30 p.m., Science Museum. Jan. 5, Wensell S. Frantzich, "The Moon."

Montreal, P. Q.: Royal Astronomical Society of Canada, 8:15 p.m., McGill University. Jan. 10, Miss I. K. Williamson, "Venus."

New York, N. Y.: Amateur Astronomers Association, 8 p.m., American Museum of Natural History. Jan. 5, film, "Destination Moon."

Rutherford, N. J.: Rutherford Astronomical Society, 8:15 p.m., YMCA. Jan. 6, Paul Hagar, "Stars"; Alfred Cox, "Winter Constellations."

HERE AND THERE WITH AMATEURS *(continued)*

State	*City*	*Organization*	*Time*	*Meeting Place*	*Communicate With*
OHIO	Lorain-Elyria	*Black River A.S.	8:00, 1st Wed.	Ely School	Leonard Sipple, Box 231
	Marietta	Marietta A.S.	Irregular	Cisler Terrace	Miss L. E. Cisler, Cisler Terrace
	Toledo	Toledo Ast. Club	...., 3rd Tue.	Univ. of Toledo Obs.	E. D. Edenburn, 4124 Commonwealth Ave.
	Warren	Mahoning Val. A.S.	8:00, Fri.	Private homes	C. R. Prather, 1363 Drexel, NW, 4494-2
	Youngstown	*Y'town A.C.	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 907 Brentwood
OKLAHOMA	Tulsa	†*Tulsa A.S.	7:30, 1st Sat.	Private homes	J. C. Wells, 524 S. 78th E. Ave.
OREGON	Portland	†*Portland A.S.	7:30, 1st Tue.	Central Public Lib.	Mrs. Marge Krutsinger, 6525NEDavisSt(16)
	Portland	†A.T.M. & Observers	8:00, 2nd Tue.	Private homes	Mrs. Marge Krutsinger, 6525NEDavisSt(16)
PENNSYLVANIA	Beaver	†*Beaver Co. A.A.A.	8:00, 2nd Tue.	Private homes	Mrs. R. T. LuCarie, Brownsdale Plan, Baden
	Millvale	A.A.A. Shaler T'ship	8:00, 1st Fri.	Cherry City Fire House	Cliff Raible, 200 Rebecca Sq. (9)
	Philadelphia	†A.A. of F.I.	8:00, 3rd Fri.	Franklin Institute	Edwin P. Bailey, LO 4-3600
	Philadelphia	†*Rittenhouse A.S.	8:00, Fri.	Franklin Institute	John W. Streeter, LO 4-3600
	Pittsburgh	†*A.A.A. of P'burgh	8:00, 2nd Fri.	Buhl Planetarium	Mary Burcik, 315 Moore Ave. (10)
	Pottstown	†Pottstown A.A.C.	7:30, Fri.	Public Library	W. E. Schultz, Public Library
RHODE ISLAND	N. Scituate	Skyscrapers, Inc.	8:00, Mon. or Wed.	Seagrave Mem. Obs.	Seagrave Mem. Obs., Box 157
TENNESSEE	Chattanooga	†*Barnard A.S.	8:00, 3rd Thu.	Jones Observatory	A. H. Jones, 411 W. 21st St., 5-1646
	Memphis	†Memphis A.S.	7:30, 1st, 3rd Fri.	Private homes	J. M. Buhler, 3796 Central Ave.
	Nashville	*Barnard A.S.	8:00, 2nd Thu.	Dyer Observatory	Miss C. Kidd, Dyer Obs., Vanderbilt U.
TEXAS	Austin	*Forty Acres A.C.	7:30, 1st Tue.	U. of Tex., Physics Bldg.	Forty Acres A.C., Box 7994, Univ. Sta.
	Dallas	†Texas A.S.	8:00, 4th Mon.	Various auditoriums	E. M. Brewer, 5218 Morningside, UN-3894
	Ft. Worth	†*Ft. Worth A.S.	8:00, 4th Thu.	Children's Museum	James M. McMillen, 604 Tierney Rd. (3)
	Port Arthur	†*Port Arthur A.C.	7:30, 2nd Thu.	5228 Fifth St.	F. T. Newton, 5213 Fifth St., 2-4807
UTAH	Salt Lake City	*A.S. of Utah	8:00, 2nd Fri.	City and County Bldg.	James W. Geertsen, 4461 S. 9th East St.
VIRGINIA	Harrisonburg	Astral Society	Monthly	Vesper Heights Obs.	M. T. Brackbill, Eastern Mennonite College
	Norfolk	†*Norfolk A.S.	8:00, 2nd Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau,LO3-4368
	Richmond	†*Richmond A.S.	8:00, 1st Tue.	601 E. Franklin St.	B. S. Ragland, 601 E. Franklin St. (19)
	Roanoke	Am. Ast'mers of Roa.	...., 2nd Fri.	YMCA	Mrs. K. Burke, 11 Mountain Ave. SE. 3-2359
WASHINGTON	Seattle	†*Seattle A.A.S.	8:00, 2nd Wed.	Eagle'n Hall, 1417 E. 42	Norman Dalke, 3640 Densmore Ave.
	Spokane	†*A.T.M.s of Spokane	8:00, Last Fri.	Private homes	Mrs. E. Mortensen, W. 1519 Augusta Ave.
	Tacoma	Tacoma A.A.	8:00, 1st Mon.	Coll. of Puget Sd.	Mrs. Roy Atkinson, 2816 N. Union Ave.
	Yakima	†*Yak. Am. Ast'mers	8:00, 2nd Mon.	Cascade Creamery	Edward J. Newman, 324 W. Yakima Ave.
WEST VIRGINIA	Fairmont	†Fairmont A.A.A.	7:30, 2nd Fri.	State Coll., Sci. Hall	David Meisel, 800 8th St.
WISCONSIN	Beloit	†*Beloit A.S.	7:30, 2nd, 4th Wed.	YMCA Bldg.	K. E. Patterson, 318 Public Service Bldg.
	Madison	†Madison A.S.	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†*Milw. A.S.	7:45, 3rd Fri.	Finney Branch Lib.	E. A. Halbach, 2971 S. 52 St. (15)
	Sheboygan	*Sheboygan A.S.	7:30, 2nd Tue.	Mead Public Lib.	T. Kruschke, 2016 N. 8th St.

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Graphic Time Table of the Heavens—1955

ON THE FOLLOWING pages is a chart that is a condensed and simple almanac, giving the rising and setting times of the sun, moon, and brighter planets, and much other useful astronomical information. This Graphic Time Table is published annually by the Maryland Academy of Sciences, through whose courtesy it is reproduced here for the 14th year. Separate copies may be obtained from the Maryland Academy of Sciences, Enoch Pratt Library Building, 400 Cathedral St., Baltimore 1, Md., for 25¢ each; on orders of 20 or more the price is 15¢ each. Large wall charts, 40 by 27 inches, are $1.00.

How to Use the Graphic Time Table

Across the top of the chart are marked the hours from 4 p.m. to 8 a.m.; the days of the year run down the chart. Thus any event, like a particular sunset, can be indicated by a point on the chart. All such points are connected by a curve, and so the time of sunset, for example, on any date in 1955 can be read from this curve, by following the horizontal line for the date to the sunset curve.

In this way the Graphic Time Table gives the rising and setting times of the sun and moon, and the planets Mercury, Venus, Mars, Jupiter, and Saturn; the duration of twilight; and the times when certain stars and other objects of interest transit, that is, cross the meridian. The moon's phases are also indicated.

Small numbers at the left give the Julian day number. These numbers are a consecutive count of the days, beginning in 4713 B.C., so that January 1, 1955, is JD 2,435,109. Julian days offer a simple way of finding the interval between two dates by a single subtraction, and they are widely used by astronomers, particularly in variable star work. The Julian day number changes at Greenwich noon, or 6 a. m., Central standard time.

Along the midnight line are Roman numerals that indicate the sidereal time at midnight, in other words, the right ascension of a star then on the meridian at the date in question. Running along the midnight line and crossing it is the curve for the equation of time, which shows how much the sun is fast if the curve is to the left of the midnight line, and how much the sun is slow if the curve is to the right of the line. When the sun is fast, it arrives at the meridian before 12 o'clock noon, by the amount shown. In other words, this curve indicates the local mean solar time for the moment at which a properly adjusted sundial would indicate noon.

Small black circles show moonset for the first half of each lunar month, and small open circles, moonrise from full to new moon. At longitude 75° west, the moon will rise about two minutes earlier than these times; at longitude 120° west, about four minutes later. Also plotted for the moon each day are little marks or "ticks," placed at the corresponding times for moonrise and moonset at the earth's equator; each tick has a horizontal bar pointing toward the time at 40° north, where the moon open or black circle is located. These marks aid interpolation for latitudes intermediate between the equator and 40° north, and may be used for cautious extrapolation to more northerly latitudes.

The scale at the right is for finding rising or setting times of other objects. Set dividers or a strip of paper from the index at the center of the scale to the object's declination, north or south (which must be known), and in the direction desired for either rising or setting. Measure this same distance along the midnight line of the chart beginning at the proper right ascension indicated by the Roman numerals. Should this end point fall outside the chart, add to or subtract from the right ascension 12 hours and reset the dividers using the end of the scale rather than the center index. Through the point established, draw a line parallel to the vernal equinox line on the chart. This will show the time of the rising or setting of the object.

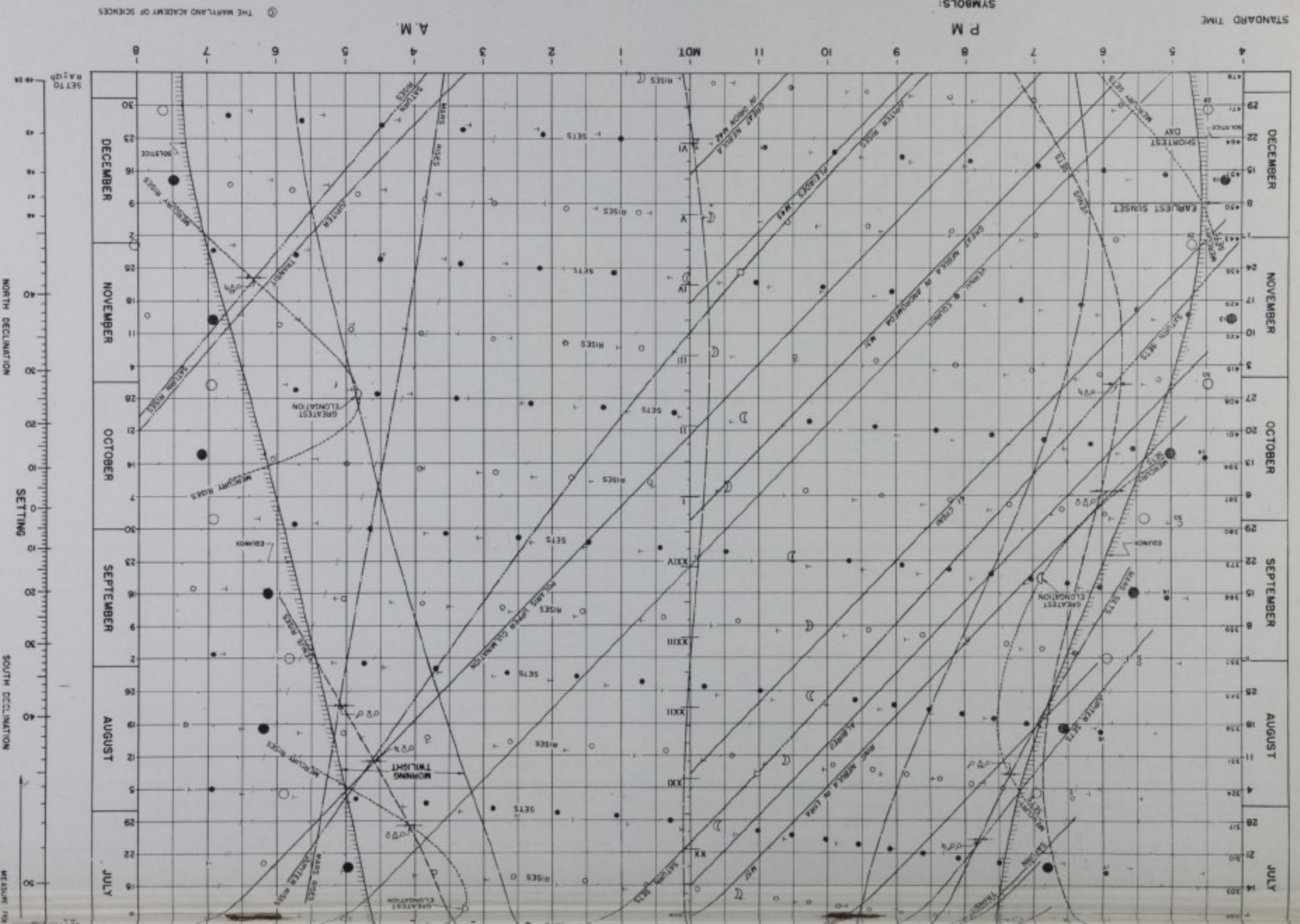
The Events of a Single Night

As an example, consider the night of January 6-7 by following the horizontal line for that date across the chart from left to right. The Julian day number is 2,435,114. The transit of Mars at 4:36 p.m. occurs before sunset, which is at 4:49. Mercury sets at 5:16; Jupiter rises at 5:29; evening twilight ends at 6:26; the upper culmination or transit of Polaris is at 6:48; the Pleiades transit at 8:41; the Orion nebula transits and Mars sets at 10:29; the sidereal time at midnight is $7^h\ 04^m$; the curve for the equation of time shows that the sun is slow, and will not arrive at the meridian until six minutes after 12 o'clock noon, local time, January 7th. Jupiter transits at 12:48 a.m.; Saturn rises at 2:53; Venus rises at 3:48; morning twilight begins at 5:45; moonset is at 6:29; Polaris is at lower culmination, or on the meridian below the pole, at 6:47; and sunrise is at 7:22 a.m. Jupiter will set and Saturn will transit at about 8 o'clock.

How to Correct for Your Position

As in all almanacs, the times of rising and setting of the sun, moon, and planets are strictly correct for only one point on the earth's surface—for this chart, latitude 40° north and longitude 90° west. The

(Continued on page 116)


STANDARD TIME
P.M.
A.M.
SYMBOLS:
NEW MOON
FIRST QUARTER
FULL MOON
LAST QUARTER
GREATEST ELONGATION
QUADRATURE
OPPOSITION
CONJUNCTION
GREATEST BRILLIANCY (VENUS)
MERCURY
VENUS
MARS
JUPITER
SATURN
EARTH
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DECEMBER
NOVEMBER
OCTOBER
SEPTEMBER
AUGUST
JULY
SETTING
NORTH DECLINATION
SOUTH DECLINATION
SET TO R.A. 12h
MORNING TWILIGHT
EVENING TWILIGHT
SUNSET
SUNRISE
MERCURY RISES
MERCURY SETS
VENUS RISES
VENUS SETS
MARS RISES
MARS SETS
JUPITER RISES
JUPITER SETS
SATURN RISES
SATURN SETS
GREATEST ELONGATION
EQUINOX
SOLSTICE
FARTHEST SUNSET
SHORTEST DAY

THE MARYLAND ACADEMY OF SCIENCES

GRAPHIC TIME TABLE OF THE HEAVENS

YEAR 1955

STANDARD TIME

SUNSET — P. M. — A. M. — SUNRISE

4 5 6 7 8 9 10 11 MDT. 1 2 3 4 5 6 7 8

JANUARY · FEBRUARY · MARCH · APRIL · MAY · JUNE

SUNSET · MERCURY RISES · MARS TRANSIT · JUPITER RISES · POLARIS UPPER CULMINATION · GREATEST ELONGATION · MERCURY SETS · EVENING TWILIGHT · EQUINOX · PLEIADES SETS · GREAT NEBULA IN ORION SETS · JUPITER TRANSIT EASTERN · REGULUS · MARS SETS · EQUATION OF TIME · SUN FAST · SUN SLOW · SATURN RISES · VENUS SETS · SETS · RISES · LATEST SUNRISE · EARTH NEAREST TO SUN · GREATEST ELONGATION · JUPITER SETS · SATURN TRANSIT · MERCURY RISES · EQUINOX · SATURN SETS · MERCURY SETS · SATURN RISES · GREATEST ELONGATION · POLARIS LOWER CULMINATION · GAMMA ERIDANI · EPSILON BOOTIS · JUPITER SETS · SATURN TRANSIT · MERCURY SETS · SATURN · MERCURY RISES · EARLIEST SUNRISE · SOLSTICE · VERNAL EQUINOX · VENUS SETS · SOLSTICE · LONGEST DAY · EARTH FARTHEST FROM SUN · LATEST SUNSET

SET TO R.A. +12h

NORTH DECLINATION 40 30 20 10 0

RISING

SOUTH DECLINATION 10 20 30 40 50

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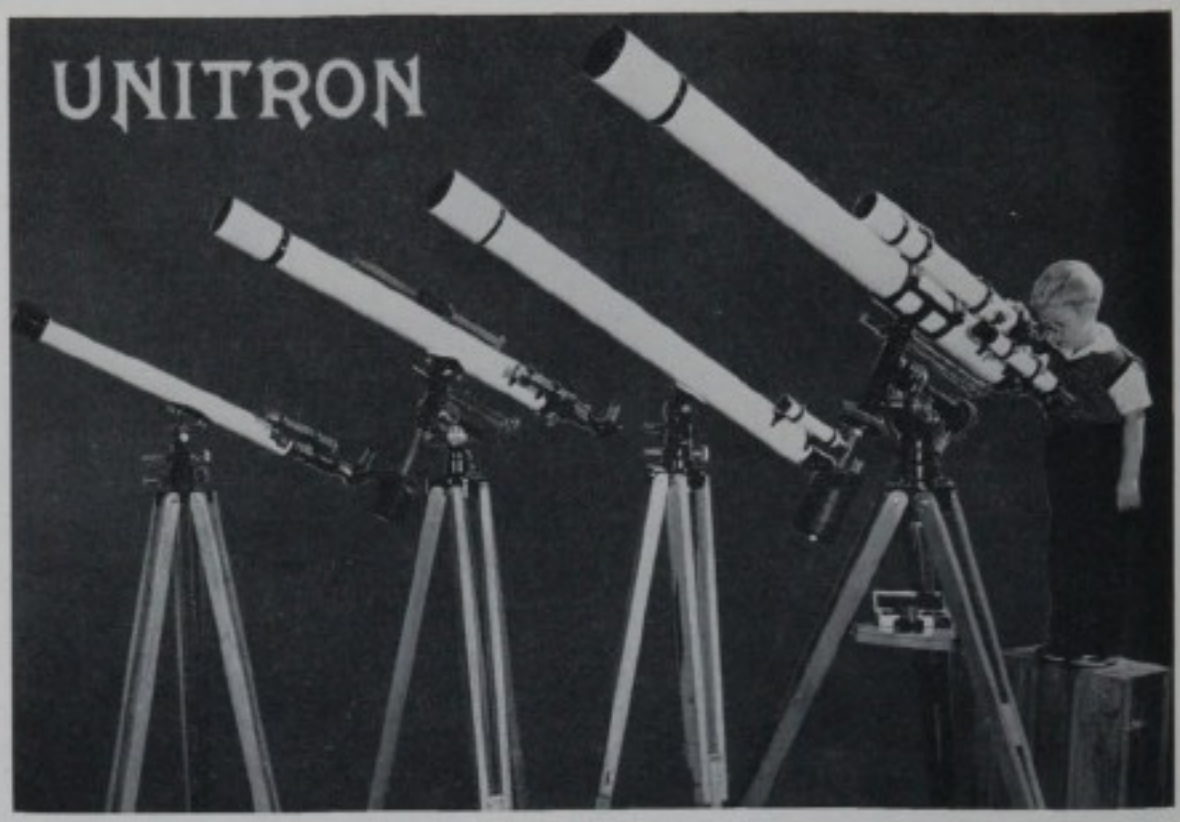
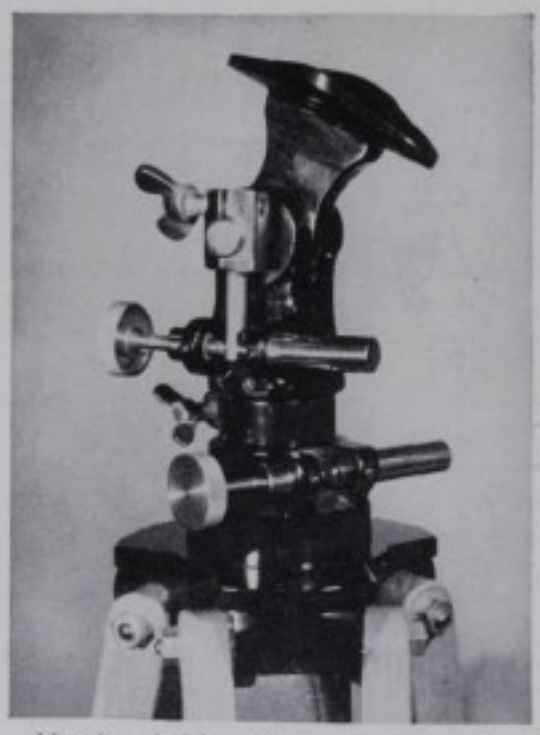


The UNITRON Refractors, left to right, are the 1.6" Altazimuth, the 2.4" Equatorial, the 3" Altazimuth, the 4" Photo-Equatorial, with a young observer.



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3" ALTAZIMUTH ($66 Down) with eyepieces for 171x, 131x, 86x, 67x, 48x	$265
3" EQUATORIAL ($108 Down) with eyepieces for 200x, 131x, 96x, 67x, 48x	$435
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4" EQUATORIAL ($196 Down) with eyepieces for 255x, 219x, 170x, 122x, 84x, 61x	$785
4" PHOTO-EQUATORIAL ($222 Down) with eyepieces for 255x, 219x, 170x, 122x, 84x, 61x	$890

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(See page 117 and the back cover)

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BOOKS AND THE SKY

DIE STERNE DUERFET IHR VERSCHWENDEN

Helmut Werner. Verlag Gustav Fischer, Eberhardstr. 10, Stuttgart, Germany, 1953. 180 pages. DM 19.

EVOLUTION of the planetarium idea from the early attempts at representation of the sky and its motions on charts and globes to the Zeiss planetarium, with the major emphasis on the last, is the theme of "The Stars Call for Your Attention." It is a well-written book in German, in a somewhat classical style, evidently by an author who is well acquainted with his subject. Indeed, Dr. Werner was director of the renowned Jena Planetarium in 1938-1945, guest lecturer at Leipzig, and associated with planetariums and the Zeiss company in one capacity or another for more than 20 years.

The order of the book is historical. The first chapter traces the development of mechanisms to represent the sky from early globes to Copernican orreries. One of the latter is on exhibit, enclosed in a glass celestial sphere, in the foyer of the Fels Planetarium in Philadelphia. There is an elaborate orrery suspended from the ceiling at the Deutsches Museum in Munich, where the observer may take his place on a moving earth and watch the apparent motions of other members of the solar system against the zodiacal background painted on the wall around the chamber.

A remote ancestor of the modern planetarium is the famous 17th-century Gottorp globe, with a representation of the earth's surface on the outside, and of the sky on its inside. Within this three-ton globe, some four meters in diameter, 10 persons may be seated on a surface representing the horizon for 54½° north latitude, and watch the diurnal motion of the sky while the big sphere turns on its axis.

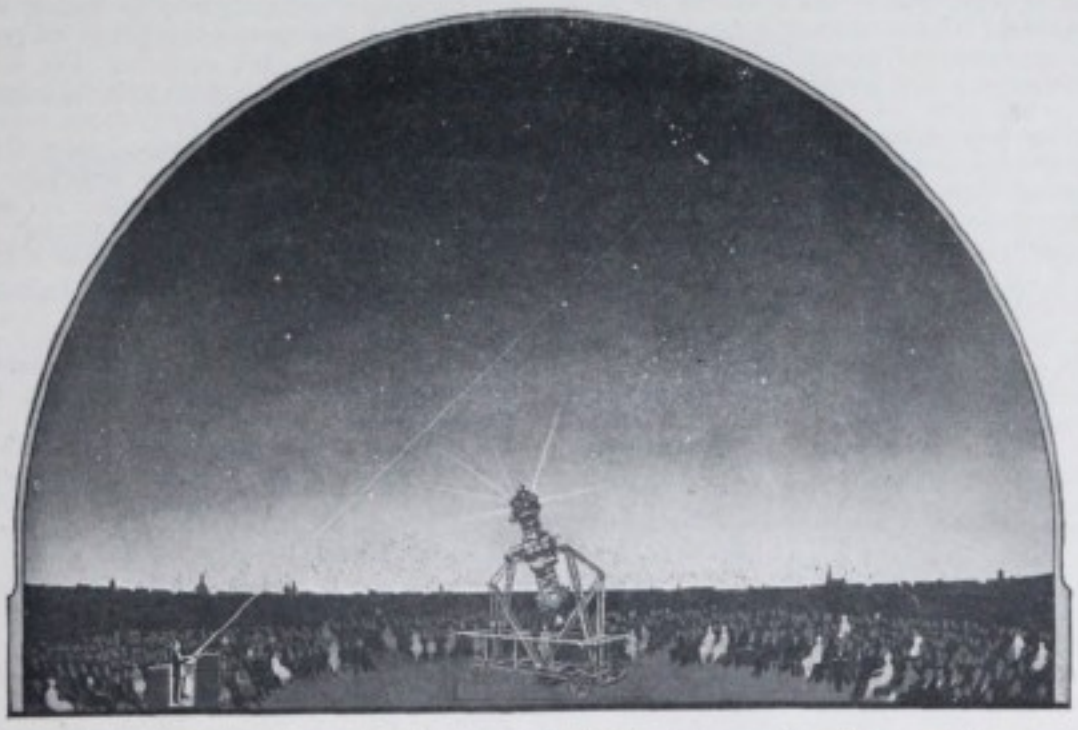
A natural extension of this idea is the Atwood sphere at the Chicago Academy of Sciences, made in 1913. This is a galvanized iron globe, somewhat larger than the Gottorp. Holes punched in its thin wall represent stars, in sizes corresponding to their apparent magnitudes. An electric motor rotates the globe around an axis inclined 42°, as a small group of spectators in the darkened interior watch the stars rise and set. The stars are made visible by the general illumination from the outside passing through the holes in the sphere.

Although a similar and perhaps larger sphere is supposed to have been constructed at Jena by Weigel in the late 17th century, I find no mention of it in this book. However, a smaller Weigel globe, now on display at the Franklin Institute in Philadelphia, is mentioned.

It was a mechanism of this type which the Heidelberg astronomer, Max Wolf, suggested to Dr. Oskar von Miller, director of the Deutsches Museum in Munich, as an astronomy exhibit. The Zeiss company was asked in 1913 to construct such a device. After unsuccessful trials of this principle, Dr. W. Bauersfeld, the engineering genius of the company, conceived in March, 1919, a completely novel system: the optical projection of star images from a central source onto the inside of a hemispherical surface representing the sky. The sun, moon, and planets were to be made to move independently, by suitably geared moving projectors. The second chapter tells of the design and construction of this prototype, which was first set up on the roof of the Zeiss works at Jena in August, 1923, and later at the Deutsches Museum. This first model was designed for a fixed latitude, but otherwise contained the essential ideas used later.

The first of the "universal" instruments, which represent the sky for all latitudes, was completed in 1926, the result of the inventive talent of Walter Villiger. This is the projector now used in many of the larger planetarium installations the world over. The complete description of this instrument in chapter three is in itself worth the purchase price of the book for one interested in details of planetariums. There is a profusion of beautiful photographs of the instrument and its components in all stages of assembly and in many operating positions.

Chapter four, "The Zeiss Planetarium Masters Space and Time," gives examples of the use of the instrument in demonstrating precessional changes over long



A German audience watches an early Zeiss planetarium in operation.

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periods, which may be valuable in certain archeological, historical, and literary researches, although most persons well acquainted with the planetarium will probably be less impressed with these possibilities than Dr. Werner. One of the best known adaptations of this use is the popular "Star of Bethlehem" show presented in many American planetariums.

Many attachments of the Zeiss instrument, to show such phenomena as comets, meteor showers, and the northern lights, are described in the fifth chapter. However, several museums have designed and built supplementary apparatus of this sort superior to that made by Zeiss.

A brief survey of the possibilities of dramatizing astronomy with the planetarium gives examples of publicity posters and releases, and suggests adding music to the program, a device universally employed.

The remainder of the book describes various planetarium installations, and in particular the projection dome—an important element. There is an excellent three-dimensional illustration of the Zeiss instrument, complete with two-color glasses for viewing it. A list of all the Zeiss installations in the world shows that only 14 are now in use, two of which are of the old type. The remainder were either partially or totally destroyed during the war. Six are now located in the United States.

This excellent book has also been issued in Germany under the title *Vom Arat-Globus zum Zeiss Planetarium*, but the only changes are in the cover and title page. We are informed that there are plans to translate the book into English. It would be a real service to persons interested in the planetarium and its use.

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Adler Planetarium

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Paul E. Wylie. Institute of Navigation, University of California, Los Angeles, 1954. 22 pages. $1.00, paper bound.

JUST AS the American nautical and air almanacs provide in convenient form the astronomical data required by mariners and aviators, so this pocket almanac gives similar information in exceedingly compact tables. Declinations and Greenwich hour angles are tabulated (with their hourly differences) to 0'.1 in the main table; but they are given only for 0^h GMT for every day, instead of at 60-minute and 10-minute intervals as in the larger almanacs. Therefore the final calculation of the GHA's requires the addition of five angles instead of the two of the larger almanacs. This additional arithmetic is the penalty paid for the conservation of space. Data are given for the vernal equinox, sun, four bright planets, and 57 navigational stars, but the moon is omitted.

The publication provides sufficient precision for the best marine navigation, and if space is ever at a premium, especially in smaller air or sea craft, and in lifeboats, this neat pocket almanac of 1½ ounces will prove of great value.

FRANCES W. WRIGHT
Harvard College Observatory

NEW BOOKS RECEIVED

THE MICROPHYSICAL WORLD, *William Wilson*, 1954, *Philosophical Library*. 216 pages. $3.75.

This is a simply written account of atomic physics by a well-known British physicist. It covers the structure of the atom, radiation laws, the origin of spectra, and the atomic nucleus. The viewpoint is largely historical, and astronomical applications are touched only slightly.

THE PSYCHOLOGY OF INVENTION IN THE MATHEMATICAL FIELD, *Jacques Hadamard*, 1954 reprint of 1945 Princeton University Press edition, *Dover Publications*. 145 pages. $2.50 cloth, $1.25 paper.

A French mathematician describes the process by which novel ideas suddenly appear in the mind of the scientific worker. The author shows how creativeness in mathematics, astronomy, the biological sciences, and the arts, follows the same pattern.

A TREATISE ON ELECTRICITY AND MAGNETISM, *James Clerk Maxwell*, 1954, *Dover Publications*. 1,006 pages. $4.95.

This classic first appeared in 1873; the present volume is a reprint of the third edition of 1891 which was prepared by J. J. Thomson. It is a systematic development of the mathematical aspects of topics such as electrostatics and electromagnetic fields.

OCCASIONAL NOTES, No. 16. 1954, *Royal Astronomical Society*, Burlington House, London W. 1. 46 pages. 6 shillings.

Short summaries of aspects of contemporary radio astronomy are given by Dr. A. C. B. Lovell and 10 of his colleagues at the Jodrell Bank Experimental Station of the University of Manchester. Radio telescopes are described, and the results of radio observations of objects from meteors to galaxies are reported.

ERFORSCHUNG DER STRUKTUR UND ENTWICKLUNG DER STERNSYSTEME, *B. W. Kukarkin*, 1954, *Akademie Verlag*, Mohrenstr. 39, Berlin W 8. 133 pages. DM 18.

The full title of this book, "Investigation of the Structure and Evolution of Stellar Systems, based on the Study of Variable Stars," describes its contents accurately. The book was originally published in Russian in 1949, and is now available for the first time in a western language.

TRANSACTIONS OF THE INTERNATIONAL ASTRONOMICAL UNION, VOLUME VIII, 1954, *P. Th. Oosterhoff*, editor, *Cambridge University Press*. 887 pages. $10.50.

This volume is the complete report of the General Assembly of the IAU held at Rome in September, 1952. The reports of 38 committees give a detailed picture of progress in all branches of astronomy, and the contributions are printed that were presented at symposia on stellar evolution, astronomical instrumentation, astrometry of faint stars, and spectra of variable stars.

ROCKET EXPLORATION OF THE UPPER ATMOSPHERE, *R. L. F. Boyd* and *M. J. Seaton*, editors, 1954, *Interscience Publishers*. 376 pages. $11.00.

The Upper Atmosphere Research Panel of the United States, and the Gassiot committee of the Royal Society held a joint conference at Oxford in August, 1953. This volume contains the papers contributed to the meeting, on subjects ranging from the V-2 as a research vehicle to the chemical composition of the upper atmosphere.

SOLAR COORDINATES 1800-2000, *Paul Herget*, 1953, *U. S. Government Printing Office*, Washington 25, D. C. 735 pages. $5.00, paper bound.

This volume contains the geocentric co-ordinates of the sun at four-day intervals for the 19th and 20th centuries. For each date the co-ordinates, referred to the sun, of the center of mass of the earth-moon system are also given. These data were derived from Newcomb's *Tables of the Sun*, no longer in print, from which the solar ephemeris in the *American Ephemeris* is computed.

This is Vol. 14 of the *Astronomical Papers prepared for the use of the American Ephemeris and Nautical Almanac*.

CAREERS AND OPPORTUNITIES IN SCIENCE, *Philip Pollack*, 1954, *E. P. Dutton*. 252 pages. $3.75.

Writing for the college or high school student who is interested in a scientific career, Mr. Pollack gives advice on qualifications, opportunities, and rewards in science and engineering. Particular attention is paid to the fields of physics, chemistry, meteorology, atomic energy, agriculture, geology, and medical research. Job possibilities in both teaching and research are described.

This book is a revision of the same author's *Careers in Science*, which appeared in 1945.

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EDITED BY EARLE B. BROWN

Notes on Basic Optics — XI

L. Ray Tracing and Lens Properties

We shall now look more closely at lenses, to find how some of their properties result from simple principles. The plan of attack is to trace a light ray through the lens. We will talk about three ways of ray tracing; the first is purely graphical, the second uses some trigonometry, and the third requires simple algebra.

For simplicity, we deal here only with lenses that have spherical surfaces, leaving aspheric surfaces for later discussion. Also, when mention is made of two lenses, we will assume that the four centers of curvature of their surfaces lie on a straight line—as is almost always the case in actual optical systems.

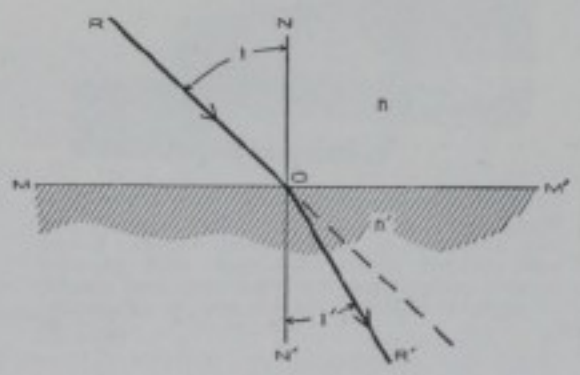

Fig. 37. The law of refraction.

1. **Refractive Index.** Every transparent substance transmits light at a velocity characteristic of the material. This velocity is conveniently measured by the refractive index of the material, which is inversely proportional to the velocity. The index of refraction of a vacuum is unity and that of air is 1.0003 (unity for most practical purposes). For glass, the index of refraction varies from 1.5 for crown to as great as 1.9 for very dense flint. This means that in crown glass light travels only about 1/1.5 or two thirds as fast as in a vacuum.

Strictly speaking, the speed of light in a transparent medium changes with wave length. This variation causes chromatic aberration in a lens system, but consideration of this effect will be postponed.

When a ray of light strikes obliquely the surface separating two materials of different refractive indexes, the ray is bent. This is seen when a pencil is thrust part way into a glass of water; the pencil appears bent at the surface. (The apparent bending of the pencil is opposite to that of the rays of light.) The rule that states how much the light is bent is the law of **refraction**, or Snell's law—one of the most important principles in optics:

$$\mathbf{n} \sin \mathbf{I} = \mathbf{n}' \sin \mathbf{I}'. \qquad (13)$$

What it means is this. The ray passes from a medium with refractive index **n** into another medium with index **n'**. **I** and **I'** are the angles of incidence and refraction, respectively, measured from the perpendicular to the surface. In Fig. 37, illustrating this situation, **MOM'** is the surface that separates the media, and **NON'** is its perpendicular or normal; **RO** is the entering ray and **OR'** the refracted ray.

Since we are dealing with a single ray which meets the surface at only one point, the surface need not be flat, or even regular, for the law to hold. Further, the same diagram could be drawn with the arrows pointed in the reverse direction, and the primed letters interchanged with the unprimed. This is a case of the **principle of reversibility**, which states that any light ray, passing across any number of refracting surfaces, would retrace the same path if it were reversed in direction. This is often a useful rule in optics.

Note that the bending occurs only at the interface between the two media. The light path within any one medium is a straight line, provided the medium is homogeneous, that is, has the same refractive index throughout. This is usually the case in optical materials. On the other hand, the atmosphere is a medium whose index gradually decreases with height, due to change in density—with important astronomical consequences.

Looking at Fig. 37 in terms of Equation 13, we see that the ray is bent toward the normal when light enters a medium with higher refractive index, that is, a denser medium. Similarly, it will be bent away from the normal when it enters a lighter medium. In general, the physical density and index of refraction increase together, although this is by no means a universal rule.

2. **Graphical Ray Tracing.** For tracing a ray of light through a refracting surface, a graphical method may be used, which will avoid the mathematical computations of the other two methods to be discussed.

In Fig. 38 let the point of incidence be **O**, and draw the normal **NN'**. Draw **RO** at the proper angle to represent the in-

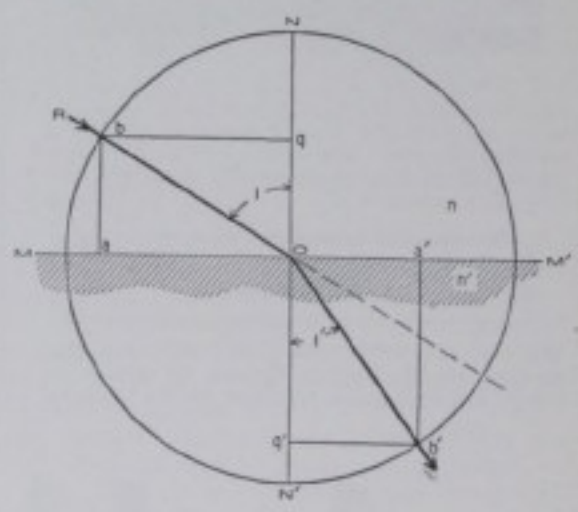

Fig. 38. Graphical ray tracing.

cident ray. Lay off on **MM′** the distances **Oa, Oa′,** so the ratio **aO/a′O = n′/n.** In the diagram we have taken the case where **n′** is greater than **n.** Erect a perpendicular from **a,** meeting the incident ray at **b.** Draw a circle around **O,** of radius **Ob.** Let a perpendicular fall from **a′,** meeting the circle at **b′.** Then **b′** is a point on the refracted ray, which may then be drawn.

The proof of the construction is: **Ob** and **Ob′** are equal, and are the hypotenuses of the two triangles **Obq** and **Ob′q′,** whose angles at **O** are the angle of incidence and the angle of refraction, **I** and **I′,** respectively. Now: **bq = bO** sin **I; b′q′ = b′O** sin **I′ = bO** sin **I′.** But **bq = aO, b′q′ = a′O** and **aO/a′O = n′/n.** Therefore, **bq/b′q′ = n′/n =** sin **I**/sin **I′.**

3. **Trigonometric Ray Tracing.** In Fig. 39, the refracting surface **OAM** is spherical with radius **r** and center of curvature at **C.** A light ray **RA,** that would meet the axis at **B,** makes an angle of incidence **I** with the normal to the lens surface at the point of contact **A.** It will be bent at **A,** according to the law of refraction, to follow the path **AB′,** whose angle of refraction is **I′.** The image point is, of course, **B′.**

In a practical case we will know beforehand **n, n′,** and **r,** and the location and direction of the incident ray. These last two can be specified by the distance **OB = D,** and the angle **U** that the ray makes with the optical axis. What we want to find are the quantities **D′** and **U′** for the refracted ray. While values of **I** and **I′** are by-products of the calculation, they are often of little interest in themselves.

(If another surface is to follow—as is usually the case—**U′** becomes the **U,** say U_2, for the second surface, and **D′** will be $D_2 + t$, where **t** is the axial separation between surface 1 and surface 2.)

To begin, we draw the perpendiculars ***Ce*** and ***Ce′,*** from the center of curvature to the incident and the refracted rays, respectively. We now see from Fig. 39 that

$$Ce = (D - r) \sin U = r \sin I, \quad (14)$$

$$Ce' = (D' - r) \sin U' = r \sin I'. \quad (15)$$

Since the external angle of a triangle equals the sum of its two opposite interior angles, $\phi = U + I = U' + I'$, we can write

$$U' = U + I - I'. \quad (16)$$

We now have all the information needed to solve the problem, and we can rewrite Equations 14, 13, and 15 in a convenient order for progressive solution:

$$\sin I = \frac{(D - r) \sin U}{r}, \quad (17)$$

$$\sin I' = \frac{n \sin I}{n'}, \quad (18)$$

$$D' - r = \frac{r \sin I'}{\sin U'}, \quad (19)$$

where **U′** is found from Equation 16.

The above equations are very convenient for anyone who does only occasional ray tracing and does not have a calculating machine, as they are suited for logarithmic computation. However, optical designers generally use a different form of the equations better suited for desk calculating machines. When large numbers of rays are to be traced, modern lens designers usually resort to high-speed electronic calculators.

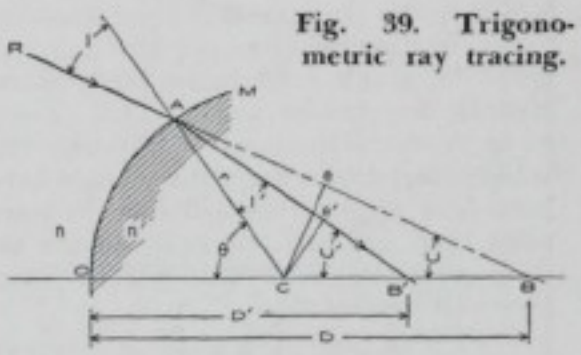

Fig. 39. Trigonometric ray tracing.

Plus and minus signs are highly important in optical calculations, and must be vigilantly watched in working out problems. If the following conventions are observed, the above equations will be true for all possible cases:

The light is always assumed to be traveling from left to right. All the distances, **r, D,** and **D′,** are positive if they lie to the right of the surface, and negative if they lie to the left. Angles **I** and **I′** are measured **from the normal** to the ray, and **U** and **U′** are measured **from the ray**

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to the axis. Angles are positive if counterclockwise, and negative if clockwise.

4. **Algebraic Ray Tracing.** The problem of tracing a light ray can be much simplified if the ray remains in the immediate vicinity of the optical axis. The simplifying principle is that a small angle is very nearly proportional to its sine—an approximation only one per cent in error for a 15° angle, and increasingly more accurate for smaller angles. This allows us to rewrite Equations 16 through 19, substituting angles for their sines, wherever these appear. We call this the **paraxial** case, and use lower-case letters to distinguish it from the general case above. We have, then:

$$u' = u + i - i', \tag{16a}$$

$$i = u\,(d - r)/r, \tag{17a}$$

$$i' = ni/n', \tag{18a}$$

$$d' - r = ri'/u'. \tag{19a}$$

In these equations, the angles may be expressed in any unit we wish—degrees, radians, mils—as long as the same unit is used throughout. The above relations combine to give

$$d' - r = \frac{nrd - nr^2}{n'd - nd + nr}. \tag{20}$$

Note that Equation 20 locates the image point **B'** and yet does not contain **u**. This is very significant, for it means that all possible rays (subject to the paraxial assumption) we can draw through the object point **B** will meet at the image point **B'**. Our lens has thus become an ideal lens (discussed in May, 1953, page 192).

A little algebraic manipulation of Equation 20 gives the general paraxial image equation for a single refracting surface:

$$\frac{n'}{d'} - \frac{n}{d} = \frac{n' - n}{r}, \tag{21}$$

in which the sign conventions stated above hold.

When the incoming light is parallel (collimated), **d** is infinite, and the corresponding value of **d'** is the **focal length, f,** of the refracting surface:

$$\frac{1}{f} = \frac{n' - n}{n'r}. \tag{22}$$

5. **Focal Length of a Lens.** We have been dealing with a single refracting surface; now we consider a lens with two surfaces, identified by the subscripts 1 and 2. We make the assumption that the lens has no thickness, which does not lead to much error in most practical cases, and which corresponds to the simple Gaussian optics used in the early part of this series. We may then equate the image distance of the first surface to the object distance of the second, that is, $d_1' = d_2$.

If the lens is working in air, n_1 is unity, n_1' equals n_2, and n_2' is unity also. Therefore, let us call n_1' and n_2 simply **n**, the index of refraction of the lens material. With the foregoing assumptions, from Equation 21 we may write for each surface,

$$\frac{n}{d_1'} - \frac{1}{d_1} = \frac{n - 1}{r_1}, \tag{23}$$

$$\frac{1}{d_2'} - \frac{n}{d_1'} = \frac{1 - n}{r_2}. \tag{24}$$

These equations may be combined and the subscripts on the distance quantities dropped, as they refer now to the lens as a whole,

$$\frac{1}{d'} - \frac{1}{d} = (n - 1)\left\{\frac{1}{r_1} - \frac{1}{r_2}\right\} \tag{25}$$

If, as above, we consider the case of parallel incoming light, **d** is infinite and the value of **d'** is the focal length of the lens. Then we have an expression for the focal length of a thin lens:

$$\frac{1}{f} = (n - 1)\left\{\frac{1}{r_1} - \frac{1}{r_2}\right\}. \tag{26}$$

(To be continued)

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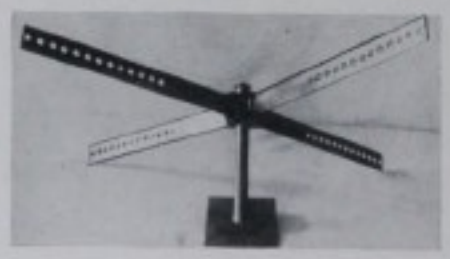

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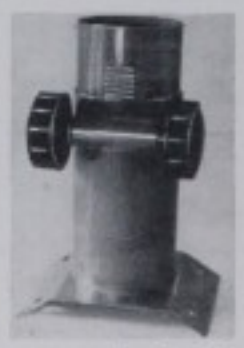

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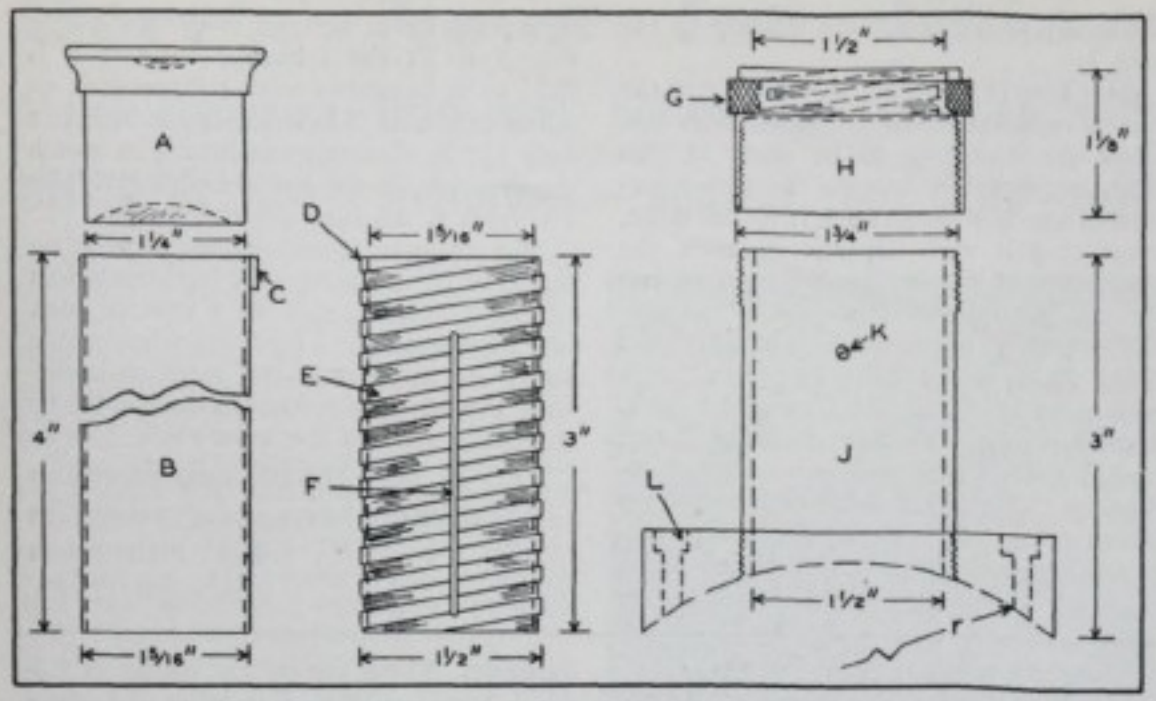

Specifications of Leo N. Schoenig's focusing eyepiece holder.

A Focusing Eyepiece Holder

THE IDEAL focusing device for the amateur telescope maker, excluding the rack and pinion, is one that has readily available both coarse and fine adjustments for positioning the eyepiece. The assembly shown in the diagram, if carefully constructed, will provide a smooth-acting focusing holder that will leave little to be desired by the ardent observer.

The entire assembly should be made of brass, for two reasons: first, the metal is easier to work in the lathe, and second, it makes a neater looking piece of equipment for the telescope.

The sketch is easily read, and a few notes on machining and other details are given herewith.

The holder is designed to use standard astronomical eyepieces, such as **A** in the figure, with an outside diameter of 1¼". Therefore, slip tube **B** should have an inside diameter of 1¼", which together with a standard wall thickness of 1/32" will result in the outside diameter being 1-5/16". The metal stop **C** on the slip tube can be soldered to the upper section after the slip tube is completed. The simplest way to get a good fit is to machine a small section of brass tubing so that the inside radius will match the outside radius of the tube. Machine the section down to a suitable thickness and then cut a portion of it to be soldered to the slip tube. For the same purpose, a complete band could be pressed to the upper section and soldered if need be.

For the next part, the focusing barrel **D**, a heavier piece of brass tubing will be needed. This tube will have a double-lead thread (Acme) cut in it so that the finished result will be a tube with an outside diameter of 1½", an inside diameter of 1-5/16", the thick wall of 3/32" being necessary to turn the four-to-the-inch external thread **E**. Also in this tube must be cut the slot **F** to take a set screw. It would probably be advisable to make the thread on a piece of tubing that is slightly longer than the finished focusing barrel, carefully cutting it to size after the thread has been successfully turned.

The tedious part to machine is the focusing nut **H**, as it takes two threads of different style, although it is not too tough for the average amateur who enjoys the challenge of a new or difficult part to make for his instrument. The nut contains a double-lead thread, four-to-the-inch internal in the upper section, and a 40-thread-to-the-inch internal cut in

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the lower section to fit on the top of the base **J**.

The knurling **G** can be done after the nut is completed. If the metal does not allow the knurling to be done at this time, assemble the nut on the upper section of the base and chuck it in the lathe, protecting it with support between the jaws and the work. Don't forget to use the tail stock for end support.

The base **J** completes the assembly, and it can either be made in one piece or in two parts, as shown. As a two-piece unit, it consists of a brass tube about 2½" long, threaded on both ends externally 40-to-the-inch. The lower section contains an internal thread to match this. The brass tube has a wall thickness of ⅛", resulting in a smooth bore internal diameter of 1½". The lower section is curved to radius r to fit the telescope tube, and is held to it by screws with countersunk or Allen heads, **L**. The telescope tube has a hole 1¾" in diameter cut into it to match the position of the eyepiece holder. The set screw **K** fits into the slot **F**.

The two-part construction permits removal of the focusing unit for attachment of other devices, such as a camera back for photography. These interchangeable units are built with the same 40-to-the-inch thread that is carried internally by the lower part of the base.

LEO N. SCHOENIG, shop supervisor
Amateur Astronomers Association
Buhl Planetarium
Pittsburgh 12, Pa.

GRAPHIC TIME TABLE OF THE HEAVENS

(Continued from page 105)

observer may easily correct for his own position.

Correction for differences in longitude are chiefly to correct one's local time, shown by the Graphic Time Table, to the standard time of our clocks and watches. This correction depends solely on the distance of the observer east or west of his standard time meridian, the latter being an even multiple of 15 degrees: 75°, 90°, 105°, and 120° west longitude in the United States. In the following tabulation, in minutes of time, all places with plus corrections are west of the standard meridian:

Atlanta	+38	Minneapolis	+13
Baltimore	+6	New Orleans	0
Birmingham	−13	New York	−4
Boston	−16	Oklahoma City	+32
Buffalo	+15	Philadelphia	+1
Chicago	−10	Pittsburgh	+20
Cincinnati	+38	Rochester	+10
Cleveland	+27	Salt Lake City	+28
Denver	0	San Francisco	+10
Detroit	+32	Santa Fe	+4
Helena	+28	Seattle	+10
Houston	+22	St. Louis	+1
Indianapolis	−16	Washington	+8
Kansas City	+18		
Los Angeles	−7		
Memphis	0		
Milwaukee	−8		

The effect of latitude differences is comparatively minor, and for most purposes may be neglected by observers within five or 10 degrees of latitude 40° north. But the Time Table contains additional information that will aid correction for any difference of latitude. These marks are very small, and must be looked for carefully—generally they "parallel" those for 40° north for the object and event concerned.

In the case of the planets, skeleton curves, giving the rising and setting times for the equator, latitude 0°, are shown—these may be connected by light pencil to aid in interpolation for other latitudes. These curves are coded as follows: Mercury, dash extending above the date line; Venus, dash extending downward; Mars, one dash above and another below the date line; Jupiter, one dot above and another below the date line; Saturn, a dash extending across the date line.

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W. J. L., Sausalito, Calif.

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"I would like to tell you what I think of my UNITRON 2.4" Altazimuth refractor. It came to hand in perfect condition. The first night the celestial objects were visible I saw Jupiter and four of its moons. To my surprise I saw its faint parallel bands clearer than I ever saw them in any other telescope. I have also seen Venus, Saturn, Mars, the nebula in Orion's sword and many others. It is also a fine terrestrial telescope."
J. D., Irvington, N. J.

"I wish to acknowledge with many thanks the receipt of the Model 114 refractor telescope. It is certainly a very fine instrument and has given me a great deal of pleasure. Certainly it measures up to your claims, and is a far better value for the money than I expected."
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(See page 108 and the back cover)

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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

The Lunar Appulse of January 8th

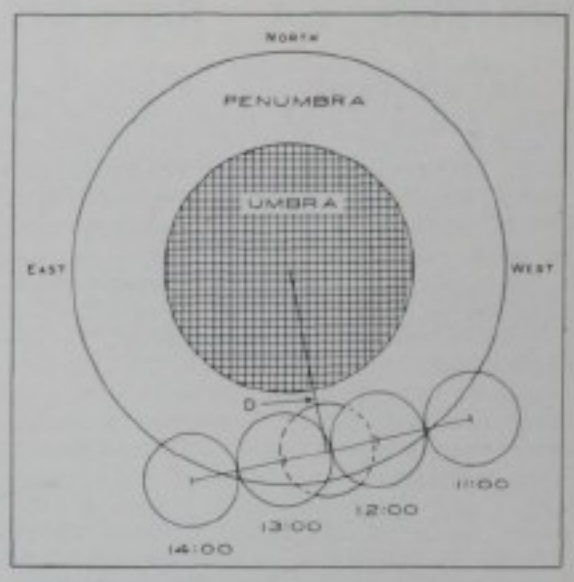
ON THE MORNING of January 8, 1955, a lunar appulse or penumbral lunar eclipse will take place, visible under varying conditions of morning twilight in the eastern part of the United States and entirely visible during darkness in the West.

The diagram shows the path of the moon relative to the umbra and penumbra of the earth's shadow, the position of the lunar disk being indicated at hourly intervals and also when it is nearest to the umbra. This deepest immersion into the partial shadow of the earth occurs at 12:32 Universal time, or at 7:32 a.m. Eastern standard time, shortly after sunrise along the Atlantic Coast.

As the minimum distance, **D**, between the moon's limb and the edge of the umbra is 16 per cent of the diameter of the moon, the magnitude of this eclipse is −0.16. For the hour from 11:00 to 12:00, when the magnitude will exceed −0.24, a darkening of the moon's northern limb should be detectable. It is difficult to predict just what effect varying conditions of morning twilight will have for observers in the eastern part of the country.

Full moon does not come until 12:44 UT, 12 minutes after mid-eclipse. This is because the moon is east of the node or point of crossing the ecliptic. Opposition of moon and sun in right ascension takes place still later, at 12:59, as the result of the change in the moon's declination during the eclipse.

This event is actually an eclipse of the moon, but there is so much light in the outer penumbral part of the earth's shadow that most appulses are inconspicuous and go unobserved except by a few enthusiasts. For those with photographic equipment, it should be possible to detect the darkening of the northern part of the disk on photographs over a much longer interval than by visual observations. Time exposures may be necessary where the moon is near the horizon.



Circumstances of the penumbral lunar eclipse of January 8, 1955.

PAUL W. STEVENS
2322 Westfall Rd.
Rochester 18, N. Y.

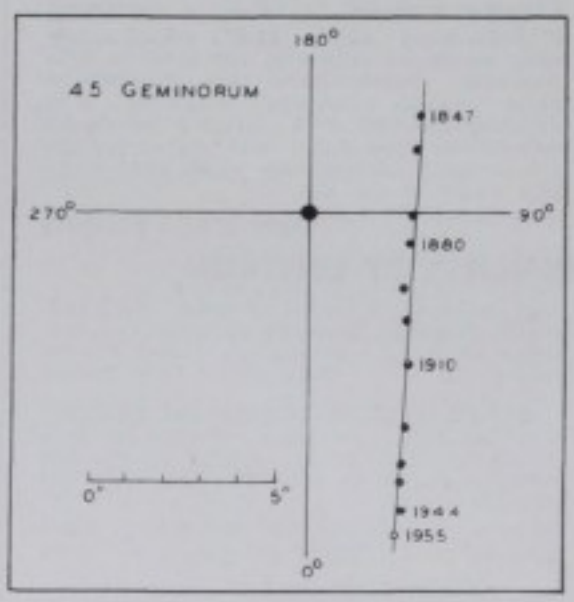
DOUBLE STAR 45 GEMINORUM

Visual double stars are of two kinds: true binaries, two stars actually near each other in space, in orbital motion; and optical pairs, two apparently neighboring stars that are, however, at widely different distances from the earth. Only the first class is of much importance to the professional astronomer, but some optical pairs can be equally worthy of observation by the amateur. A little-mentioned optical double is described here.

The 5.6-magnitude star 45 Geminorum ($7^h\ 05^m.5$, +16° 01′, 1950) is easily found four degrees south of ζ Geminorum and two degrees west of λ Geminorum. It has an 11th-magnitude companion first recorded by Otto Struve at Poulkovo Observatory a century ago. The present separation of this optical pair is nine seconds of arc, making it not too hard for a 6-inch telescope. About 1875, when the two stars were closest, they were only 2.8 seconds apart, and the pair was difficult because of the large difference in their brightnesses.

The relative motion shown in the diagram is due to the brighter star, which is drifting nearly due south at about 11 seconds of arc per century, while the companion remains practically fixed.

J. A.



In this diagram, the brighter star is considered stationary at the center. The open circle is a prediction from W. J. Hussey's formula.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

FINDING VENUS BY DAY

This ephemeris continues that first presented on page 353 of the August, 1954, issue, where Franklin Miller, Jr., gave a detailed explanation.

Sirius, −1.6; January 1, 8:59, N; 2, 9:03, N; 3, 9:06, N; 4, 9:09, N; 5, 9:12, N; 6, 9:16, N; 7, 9:20; 8, 9:23, S; 9, 9:26, S; 10, 9:30, S; 11, 9:34, S; 12, 9:38, S; 13, 9:42, S; 14, 9:45, S; 15, 9:49, S; 16, 9:53, S; 17, 9:57, S; 18, 10:01, S.

β Leporis, +3.0; January 19, 11:22, N; 20, 11:26, N; 21, 11:30, N; 22, 11:34, N; 23, 11:38, N; 24, 11:43, N; 25, 11:47, N; 26, 11:51, N; 27, 11:56, N; 28, 12:00, N; 29, 12:04, N; 30, 12:09, N; 31, 12:13, N. February 1, 12:18, N; 2, 12:22, N; 3, 12:27, N; 4, 12:31, N; 5, 12:36, N.

Example: Locate Sirius, magnitude −1.6, during the night of January 1st, and line it up with some terrestrial landmark. Add eight hours 59 minutes to the time of the observation, and use the same landmark to look for Venus on the following day. If your Sirius observation is made at 11:30 p.m., Venus should be in the same place in the sky at 8:29 a.m. on January 2nd. The difference in declination between the selected finder stars and Venus will always be less than about two degrees. In the list, N means that Venus will be slightly to the north of the star; S that it will be slightly to the south.

MINIMA OF ALGOL

January 2, 7:46; 5, 4:35; 8, 1:24; 10, 22:13; 13, 19:02; 16, 15:51; 19, 12:40; 22, 9:29; 25, 6:18; 28, 3:07; 30, 23:57. February 2, 20:46; 5, 17:36; 8, 14:25.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

OCCULTATION PREDICTIONS

January 6-7 **1 Geminorum** 4.3, 6:01.4 +23-16.1, 13, Im: **A** 9:17.8 −0.1 −1.3 97; **B** 9:13.6 −0.2 −1.3 92; **C** 9:22.2 −0.1 −1.5 110; **D** 9:15.0 −0.2 −1.5 102; **E** 9:18.4 −0.2 −1.9 125; **F** 9:43.2 +1.1 −4.3 170; **I** 8:37.6 −1.0 −2.3 135.

January 19-20 **Theta Ophiuchi** 3.4, 17:19.2 −24-57.4, 26, Em: **H** 13:57.2 −0.4 −0.4 319.

February 4-5 **g Geminorum** 5.0, 7:43.5 +18-37.3, 12, Im: **E** 10:46.3 +0.4 −1.9 140; **F** 11:11.1 +1.0 −3.2 174; **I** 10:30.6 +0.1 −2.9 162.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the **American Ephemeris** and the **British Nautical Almanac** are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo** — **LoS**), and multiply **b** by the difference in latitude (**L** — **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

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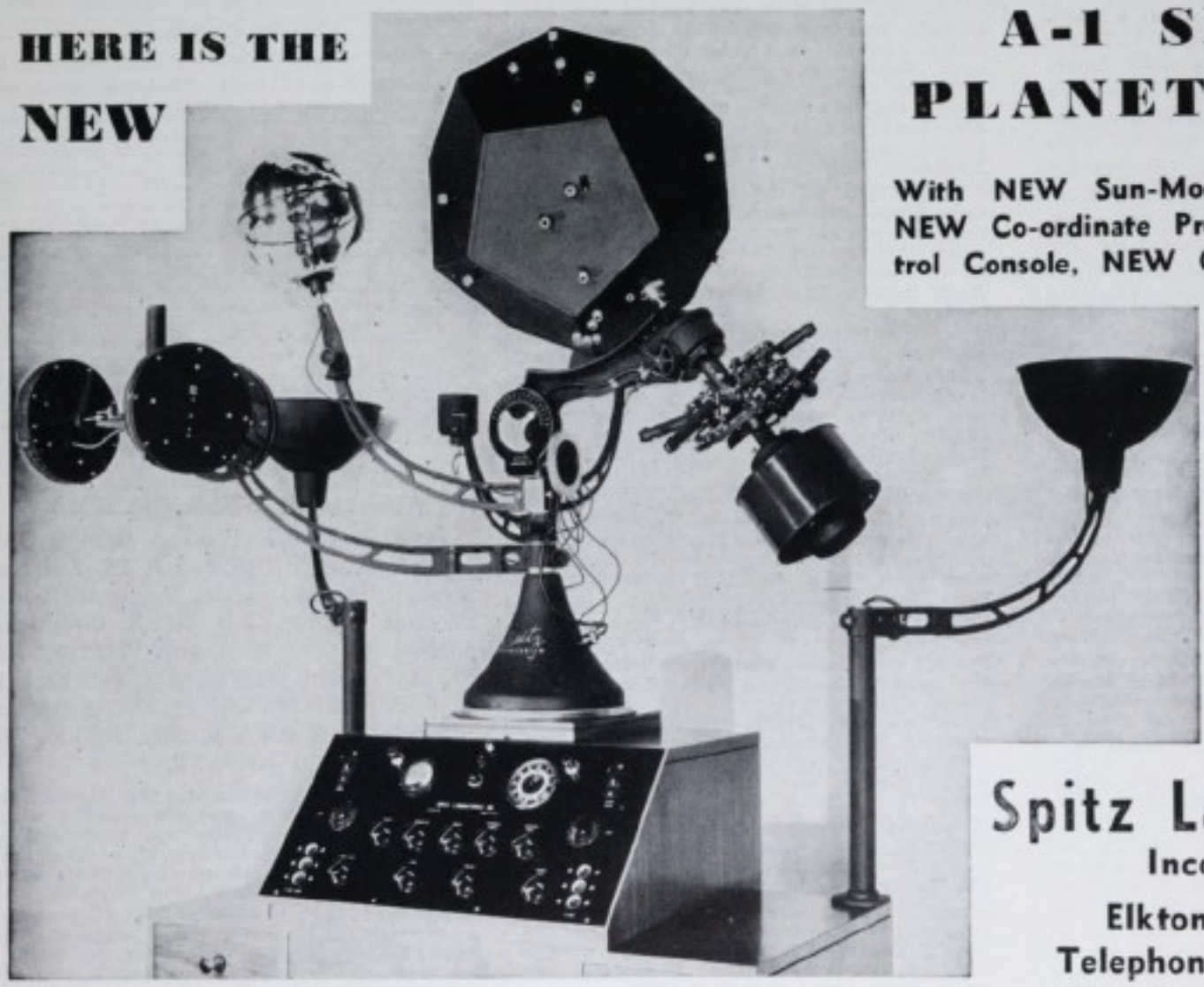

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SKY AND TEACHER

(Continued from page 100)

Field Book of the Skies, William T. Olcott, revised by R. Newton Mayall and Margaret L. Mayall. G. P. Putnam's Sons, New York, 1954, $5.00. A handbook for observers and telescope users, presenting the constellations individually, grouped by seasons when best observed in the evening. There is a naked-eye and a telescopic chart for each constellation. This is a newly rewritten version of a well-known work by William Tyler Olcott.

Atlas of the Stars, Harold B. Webb, 145 President St., Lynbrook, N. Y., $5.50. Contains 10 finder charts and 110 atlas charts with stars to the 9th magnitude from the north pole to −23° declination. The epoch is 1920 with corners plotted for 2000. A variable star index is included. The cloth-bound book has 149 pages, 8 by 10 inches.

It is evident that certain broad subject fields of interest to astronomy enthusiasts have been omitted from the foregoing series, such as astronomical history and biography. Some telescope making books will be listed in March.

GRACE C. SCHOLZ, chairman
Astronomical League Book Service
166 Mason Hall Apts.
Alexandria, Va.

PHOTOGRAPH CORRECTION

On page 365 of the September issue, my photographs of the June 30th eclipse that are labeled 5:20 a.m. and 5:25 a.m. should be interchanged. Numerous readers have told me of this error, which evidently arose when I was mounting the prints.

JOHN F. BICKING
812 Middlesex St.
Gloucester, N. J.

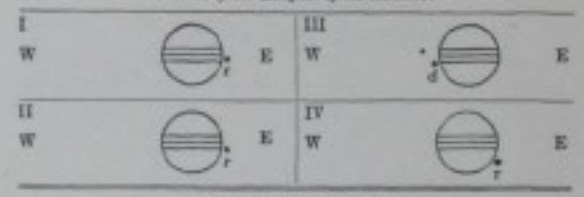
JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the right. In the upper part, *d* is the point of disappearance of the satellite in Jupiter's shadow; *r* is the point of reappearance.

In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot to the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac*.

JANUARY

Phases of the Eclipses of the Satellites



Configurations at 0h 00m

VARIABLE STAR MAXIMA

January 7, RT Hydrae, 082405, 7.6; 15, RS Librae, 151822, 7.7; 20, Z Ursae Majoris, 115158, 6.6; 26, V Canum Venaticorum, 131546, 7.1; 26, X Ophiuchi, 183308, 6.9; 30, R Bootis, 143227, 7.3; 31, RU Cygni, 213753, 8.0. February 1, R Corvi, 121418, 7.6; 1, V Cassiopeiae, 230759, 7.9; 6, RV Centauri, 133155, 7.6; 7, R Normae, 152849, 7.2.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

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FOR SALE: Carl Zeiss astronomical eyepieces, formerly used with 9½" Carl Zeiss objective sold to City of Los Angeles (Griffith Observatory). Kellners: one 60-mm. and one 40-mm.; orthoscopics: two 25-mm., two 15-mm., one 9-mm., and two 7-mm. $175.00 for the lot. Also large Carl Zeiss prism erecting system, $75.00. James V. Wyber, 4756 Myrtle St., Montebello, Calif.

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BRITISH ASTRONOMICAL Association's *Handbook* for 1955, $1.50; Norton's *Star Atlas*, $5.25; Moore, *Guide to the Moon*, $3.95; *Guide to the Planets*, $4.95; *Bonner Durchmusterung*, northern parts, $62.50, southern parts, $38.50. All domestic and foreign publications. Write for list. Herbert A. Luft, 42-10 82nd St., Elmhurst 73, N. Y.

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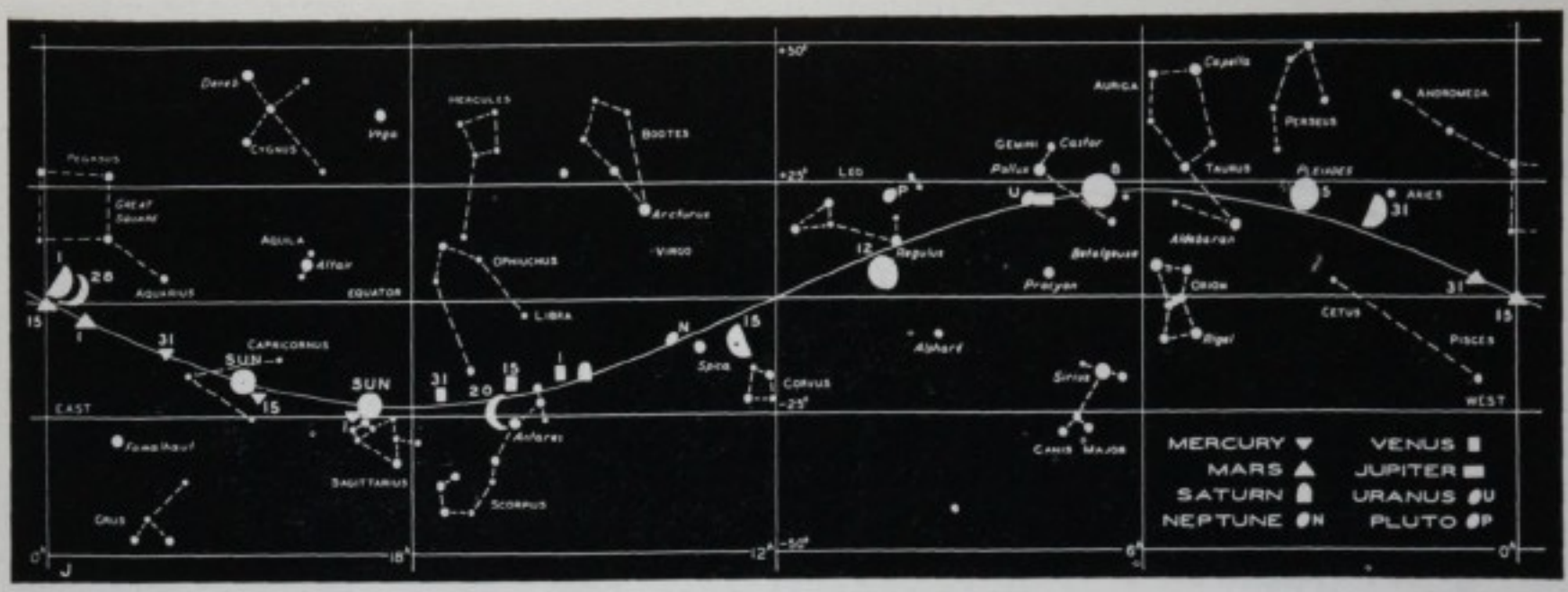

THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury, in the evening sky, attains greatest elongation on January 28th, 18° 26′ east of the sun. At the end of the month, the elusive planet appears of zero magnitude and sets 1½ hours after the sun.

Venus continues brilliant in the morning sky, reaching greatest western elongation on the 25th, 46° 57′ from the sun. At that time the planet shines at magnitude −4.1, and rises three hours before the sun. In a telescope, Venus has the phase of a quarter moon and an apparent diameter of 25″.

Mars, as it travels rapidly eastward, crosses the equinoctial colure in western Pisces on the 15th, when it is magnitude +1.0, and sets about 5½ hours after the sun. Mars is now of little interest telescopically as its disk is only 6″ in diameter.

Jupiter is visible all night, as opposition occurs on January 15th. It is a brilliant −2.2 magnitude. Jupiter is in retrograde motion in easternmost Gemini, and its disk is 46″ in equatorial diameter at opposition.

Saturn, of magnitude +0.8, is moving eastward in Libra, rising about 2 a.m. local time at midmonth. The ring system is inclined 22° to our line of sight, with its northern face exposed.

Uranus, situated near Jupiter, comes to opposition on January 16th. On the 6th these two planets are in conjunction —their second of three conjunctions this season—as Jupiter in its more rapid westward motion passes 9′ south. With field glasses, 6th-magnitude Uranus can be easily identified at this time.

Neptune rises about midnight, passing western quadrature with the sun on the 19th. This 8th-magnitude object is moving eastward in Virgo, about 6° east of Spica.

E.O.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Egeria, 13, 9.3. Dec. 24, 8:24.2 +44-05. Jan. 3, 8:15.5 +45-46; 13, 8:03.8 +47-05; 23, 7:50.8 +47-49. Feb. 2, 7:38.7 +47-56; 12, 7:29.5 +47-30.

Euterpe, 27, 8.7. Jan. 3, 8:38.5 +19-33; 13, 8:30.2 +20-17; 23, 8:20.2 +21-03. Feb. 2, 8:10.2 +21-45; 12, 8:02.0 +22-15; 22, 7:56.8 +22-33.

Hebe, 6, 8.6. Jan. 3, 8:39.1 +9-48; 13, 8:30.5 +11-10; 23, 8:20.7 +12-45. Feb. 2, 8:10.8 +14-23; 12, 8:02.2 +15-58; 22, 7:55.9 +17-24.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1955.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

JANUARY METEORS

The Quadrantid meteor shower, seen about January 3rd each year, is probably the least known of the major streams, although it has been observed for over a century. Quadrantids move with medium speed; since most of them are faint, favorable conditions are needed. This year lunar conditions will be fair. The moon will be in Aries, two days past first quarter, setting about 2 a.m.

Interesting radio observations of this shower were carried out on January 3, 1951, at the Dominion Observatory, Ottawa, Canada, by P. M. Millman and D. W. R. McKinley. Over 120 meteor velocities were recorded by radio from 2 p.m. to 7 p.m. EST; shower activity reached a sharp peak at 5:29 p.m., when the hourly rate was 50. The average geocentric velocity of these meteors was found to be 40.9 kilometers per second, indicating that they move around the sun in elongated orbits, with a period of seven years.

These observations demonstrated the short duration of the shower. Watch for it early in the evening of January 3rd. The meteors will appear to radiate from a point east of the end of the Big Dipper handle, where the obsolete constellation of Quadrans Muralis was located.

E. O.

SUNSPOT NUMBERS

October 1, 0, 0; **2**, 0, 7; **3**, 2, 14; **4**, 3, 8; **5**, 2, 7; **6**, 2, 0; **7**, 0, 0; **8**, 3, 0; **9**, 1, 0; **10**, 0, 0; **11**, 3, 0; **12**, 5, 7; **13**, 7, 7; **14**, 12, 15; **15**, 19, 17; **16**, 15, 24; **17**, 1, 22; **18**, 2, 7; **19**, 8, 8; **20**, 8, 14; **21**, 8, 8; **22**, 11, 8; **23**, 10, 14; **24**, 9, 8; **25**, 9, 8; **26**, 7, 7; **27-31**, 0, 0. Means for October: 4.7 American; 6.8 Zurich.

Dr. M. Waldmeier, of Zurich Observatory, has made the following predictions of the smoothed monthly sunspot numbers for the first months of 1955: January, 7; February, 8; March, 9; April, 10.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by D. W. Rosebrugh from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

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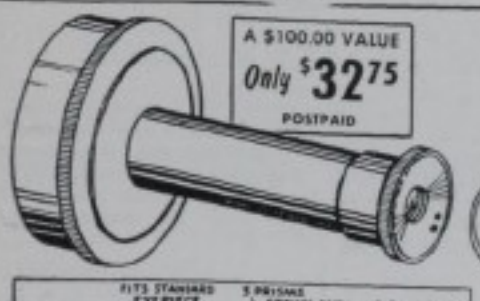

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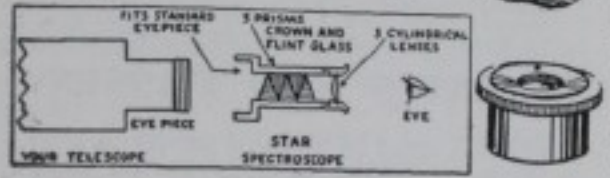

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Designed to check navigational instruments. Used by industry as a collimator for optical instruments, for testing lenses for definition, as a source of infinite light, and for photographing reticles at infinity. Purchased by many firms as a source for the fine lenses and parts it contains. Consists of a large cemented achromat, 5" in diameter, with a focal length of approximately 25", a pinpoint reticle lighted by a 6-8-volt bulb (to represent a star), a first-surface mirror to reflect the light from the reticle. Overall length 14⅜"; width of cradle 7⅜". Slightly used, but in good working order.

Stock No. 80,025-Y $95.00 f.o.b. Barrington, N.J.

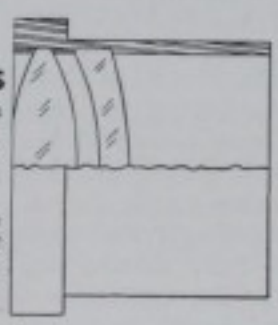
BUBBLE SEXTANT

War Surplus Type A-10A You Save 90%

A terrific bargain. Govt. cost about $217.00. Cost to you only 10% of this figure. Each instrument has been checked to assure proper collimation and perfect working order. Electric (battery-operated) automatic recording averaging device. Illuminated averaging disk for nighttime use. Comes with carrying case, spare plastic disk, flashlight with rheostat, auxiliary 2x Galilean telescope for use on faint stars, and direction booklet. We guarantee satisfaction!

Stock No. 933-Y ..... $22.50 Postpaid

HEIGHT-FINDER OBJECTIVES



War surplus $100 Value!

PRECISION HEIGHT-FINDER AIR-SPACED ACHROMATIC OBJECTIVE

Mounted in metal cell.

Excellent for collimators or telescope objectives. These top quality objectives were used in the army's $12,000.00 Heightfinder. Made obsolete by radar, they have been subjected to very little use. Color corrected. 64 mm. (2-9/16") in diameter. 18.2" focal length. Perfectly matched pairs.

Stock No. 70,038-Y .. $50.00 Pstpd.
Purchased singly,
Stock No. 70,037-Y $25.00 each Pstpd.

30X TELESCOPE

with Tripod

Bargain! Imported! Focuses from 40 ft. to infinity. Achromatic objective. Lens erecting system. Length 26¼".

Stock No. 70,018-Y
$21.95 Pstpd.

MOUNTED BARLOW LENS

Short Focal Length

E.F.L.: —1.74±0.01 inches
CLEAR APERTURE: 0.96"
O.D. OF CELL: 1-3/16"

A negative achromat called a Barlow lens is used to convert your astronomical objective—lens or mirror—into a telephoto system. Thus a variable-power astronomical telescope is obtained. The great advantage of this system is that higher powers may be obtained without resorting to very short focal length eyepieces or very long and cumbersome telescopes.

Our Barlow lens is well made, finely corrected so that no image deterioration is sustained. Short focal length allows the lens to be used closer to the primary focus, thus making it convenient to use as part of the eyepiece system. Short focal length also insures that the total length of the telescope will not be increased an impracticable amount.

Direction sheets on the use and the mounting of the Barlow lens are available.

Stock No. 30,140-Y ..... $15.00 Postpaid

Be Sure To Get FREE CATALOG "Y"

If you haven't seen our big, FREE Catalog, you don't know what you're missing. Fantastic variety — never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Dozens of other hard-to-get optical items. Write today for FREE CATALOG "Y".

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4¼" ASTRONOMICAL TELESCOPE

BRAND NEW!

"Palomar, Jr."

ONLY

$74.50 complete

A REAL REFLECTOR TELESCOPE

Complete With Equatorial Mount, Tripod.

Designed by us to meet every need of the amateur astronomer! Specially engineered not only for blueprint precision, but for comfort, ease of operation and freedom from mechanical restrictions! 4¼" mirror **guaranteed** to give theoretical limit of resolution. Diagonal and combination eyepiece finished to equal or better tolerances than mirror. Look at all these revolutionary features: Rack and pinion, micrometer-smooth focusing with tension adjustment. Two-piece rigid diagonal construction. All-aluminum black anodized tube. No-distortion adjustable mirror mount, easily removed for mirror cleaning. Tube ventilated. **Real** equatorial mount—one smooth motion follows stars, planets. Sturdy hardwood tripod. Counterweight for perfect balance. Latitude adjustment easily made with tripod setting.

Technical specifications: mirror aluminized, overcoated with silicon monoxide. Focal ratio f/10.5. Focal length 45". Combination eyepiece gives powers of 57X (20 mm.) and 115X (10 mm.). A 6-mm. eyepiece, available from us at extra cost, gives 190 power. All eyepieces are standard 1¼" diameter. Focus travel of eyepiece mount is 2¾". Tube finished in jet black, accessories in black wrinkle finish. Tripod stained natural wood.

Stock No. 85,006-Y .... complete .... $74.50 f.o.b. Barrington, N. J.

"MAKE-YOUR-OWN" 4-1/4" MIRROR KIT

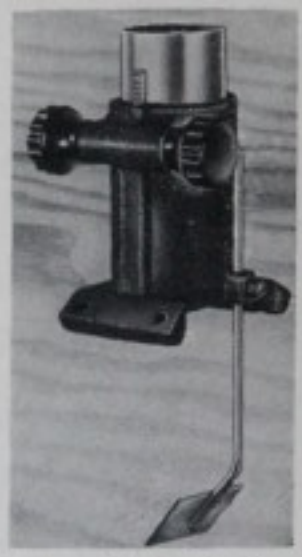
The same fine mirror as above, polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

Stock No. 50,074-Y

$16.25 Postpaid

RACK and PINION EYEPIECE MOUNT

. . . Available with Diagonal Holder



Now—you can improve performance in a most important part of your telescope—the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance out of your present telescope whether you bought it "ready made" or built it yourself! Look at all these wonderful new features: Real rack and pinion focusing, with variable tension adjustment, gives you microscope-smooth focusing action. Focus travel over 2". Drawtube accommodates standard 1¼" eyepieces, giving your present telescope a wide, varied range of power. Standard size opening also allows the use of accessory equipment, such as sunspot projectors, filters, eyepiece prism diagonals and terrestrial erectors. Lightweight aluminum body casting. Rigid mounting achieved by drilling four small holes in tube, whether paper or metal. Drawtube and rack chrome plated brass, body in black wrinkle finish.

Add beauty and ease of operation to your present telescope—at low cost!

Stock No. 50,077-Y ..... Only $8.95 Postpaid

DIAGONAL HOLDER

Designed as an accessory to the eyepiece holder. Single screw centers the diagonal in any size tube up to 8". Accurate 45-degree angle eliminates excessive preliminary adjustments. Rigid one-piece construction of rod makes frequent changes of adjustment unnecessary, allows more light to reach mirror. Includes double-faced adhesive tape to attach front surface mirror to plate—set it and forget it!

Stock No. 60,035-Y ..... $1.00 Postpaid

TELESCOPE EYEPIECE — Consists of 2 Achromatic lenses. F.L. 28 mm. in a metal mount.

Stock No. 5140-Y.. $4.50 Postpaid

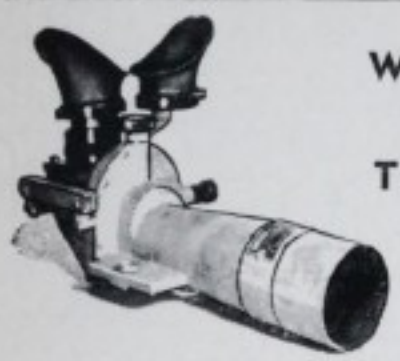
Same as above but about 1¼" extension has been added with O.D. of 1¼", which is standard.

Stock No. 5223-Y.. $5.25 Postpaid

50x MICROSCOPE & 10x TELESCOPE

New 2 in 1 combination! Pocket size! No larger than a fountain pen. Sharp focus at any range. Handy for sports, looking at rare objects or just plain snooping.

Stock No. 30,059-Y $4.50 Postpaid



War Surplus ELBOW TELESCOPE M-7

8 Power

U. S. Govt. cost about $300.00!

Cemented achromatic doublet objective, F.L. 8⅝", speed f/4.5, clear aperture about 45 mm. F.L. of eyepiece 27 mm. Amici roof prism erector. Eye relief 25 mm. Field of view 6°. Length 12", width 5", height 6". Weight 3¾ lbs.

Stock No. 70,044-Y ..... $27.50 Postpaid

60° SPECTROMETER PRISM

Polished surfaces flat to ½ wave length. Angle tolerances 5 minutes. Dimensions of polished surfaces 18 mm. x 30 mm. Made from dense flint glass, free of striae and strain.

Stock No. 30,143-Y ..... $8.25 Postpaid

15X SPOTTING SCOPE

A miniature scope with amazing big-scope qualities! Only 7" long, fits handily in the side pocket of your jacket. Collapsible triped with ball-joint mount for viewing in any direction and "fixing" on target. Coated objective lens, Ramsden eyepiece, achromatic objective. Threaded focus adjustment. Rubber feet on tripod. Total height 10".

Stock No. 70,035-Y $19.95 Postpaid

ASTRONOMICAL MIRROR MOUNTS

Cast aluminum with brass mounting and adjusting screws and mirror clamps. Two sizes: for 6" mirrors—mount will fit 7" I.D. tube:

Stock No. 50,010-Y .... $7.00 Postpaid

For 4¼" mirror—mount will fit 5" I.D. tube:

Stock No. 50,011-Y .... $5.25 Postpaid

U. S. ARMY SURPLUS TRIPLE TURRET TELESCOPE

A Sensational Buy — Dozens of Uses

Eyepieces for 15, 23 and 30 power mounted on a rotating turret. Par focal. 3" dia. achromatic objective. MOUNT: Rotate 360° in azimuth. Bubble level on elevation control. Instrument has prism-erecting system—brass construction. Length 20". Max height 72". Used but in good condition. Comes with leather carrying case for telescope and mount; fiber case for tripod.

Stock No. 85,003-Y ..... $89.50 f.o.b. Barrington, N. J.

(Shipping Wt. 70 lbs.)

ORDER BY STOCK NUMBER . . . SEND CHECK OR MONEY ORDER . . . SATISFACTION GUARANTEED!

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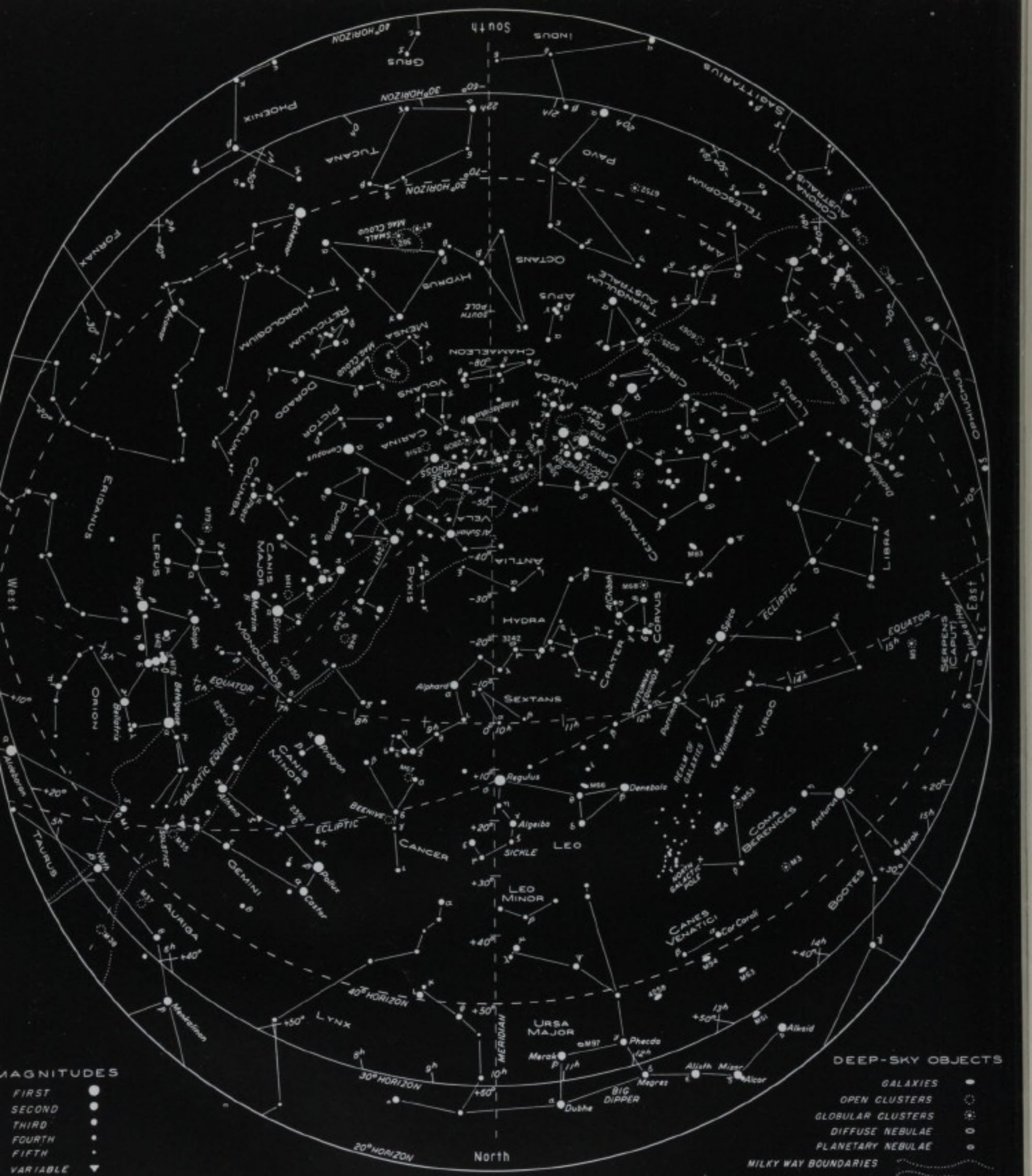
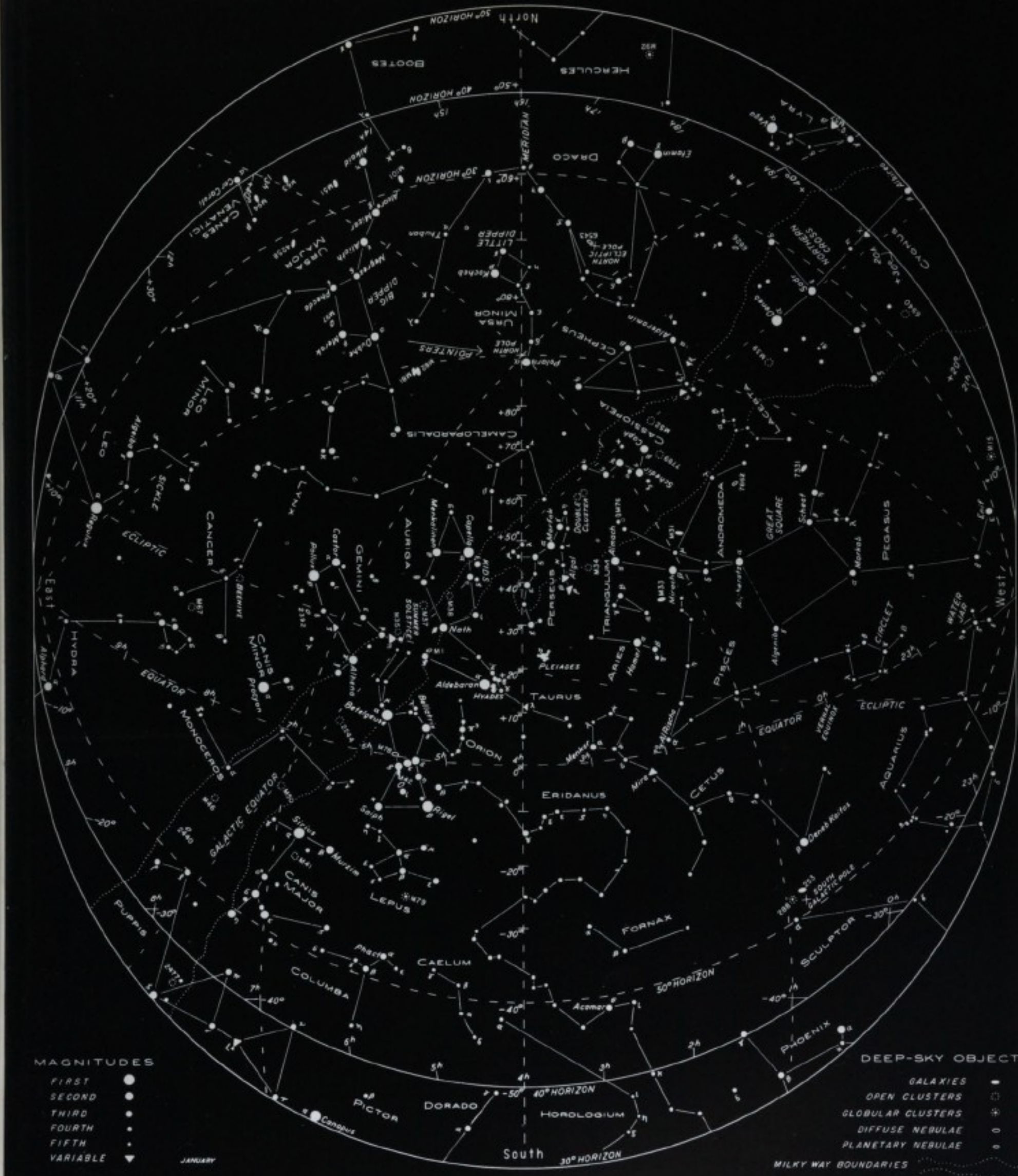


SOUTHERN STARS

The sky as seen from latitudes 20° to 40° south, at 11 p.m. and 10 p.m., local time, on the 7th and 23rd of March, respectively; also, at 9 p.m. and 8 p.m. on April 7th and 23rd. For other dates, add or subtract ½ hour per week.

The true Southern Cross and the False Cross are in dominating positions at this time of year. The former, Crux, contains two 1st-magnitude stars, and the line from top to bottom of the cross points to the south pole of the sky. The False Cross passes neither of these tests.



STARS FOR JANUARY

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of January, respectively; also, at 7 p.m. and 6 p.m. on February 5th and 21st. For other dates, add or subtract ½ hour per week.

The beginner should look for the six 1st-magnitude stars that form an elliptical figure with Betelgeuse near its center. The six stars are Sirius in Canis Major, Procyon in Canis Minor, Pollux in Gemini, Capella in Auriga, Aldebaran in Taurus, and Rigel in Orion.

Messier 33 is just below the center of this picture, and the bright stars of Triangulum are at the left. A line from Mu Andromedae, in the upper right corner, through Beta Andromedae points nearly to M33. This is a Harvard Observatory photograph, with a 3-inch patrol camera, exposure two hours on November 11-12, 1950.

DEEP-SKY WONDERS

THE GREAT SPIRAL in Triangulum, also known as M33 and NGC 598, is a favorite of photographers and the despair of many visual observers. Amateurs have often searched telescopically without avail for this apparently elusive object, while others report it visible in finders or binoculars. Until recently no one had reported a naked-eye observation to me, although the rather discordant measurements of its integrated visual magnitude, 5.8 to 6.8, suggest that M33 might be seen in a really clear sky.

M33 is at $1^h\ 31^m.1$, $+30°\ 24'$, 1950 coordinates.

Only one published reference to such naked-eye visibility has been found. Knut Lundmark, discussing the limits of non-telescopic vision in the **Handbuch der Astrophysik**, Vol. VI, Part 1, page 354, states, "The present writer is able to see with his unaided eye the object M33 having a total magnitude of 6.8."

Last September, while observing meteors eight miles east of Manhattan, Kan., I stumbled on the nebula accidentally. It was so obvious that at first I took it for a bit of cloud, but binoculars corrected the identification. To the unaided eye, stars well below magnitude 7.0 were easily visible that evening, and the nebula itself was a conspicuous luminous patch, very slightly brighter at the center, and apparently larger than its published major diameter of 60 minutes of arc. I made it easily 90 minutes, but somewhat less in binoculars.

Postcards were sent to other amateurs, whose attempts to verify the naked-eye visibility of M33 are reported here. Harold Peterson after several failures in Durango, finally saw "a faint diffuse patch of light with a suggestion of a core," which he was not able to hold steadily in view. This was in the Vallecito River canyon in Colorado. A. D. Peterson saw M33 clearly from the mountains 40 miles west of Grand Junction, Colo., and his son made it out from the city itself. S. R. B. Cooke writes that while it was invisible from Minneapolis, he could see it clearly with the unaided eye at 6,000 feet in the Montana Rockies. At Neosho, Mo., R. Adams detected it as a faint haze, best seen by averted vision.

Five other observers wrote me of unsuccessful attempts to see M33. One of these, James Corn, of Phoenix, Ariz., also remarked, "Dr. Carpenter showed me M33 through the 36-inch [reflector at Steward Observatory] and I noticed a condensation in one of the spiral arms. When I got home I tried my 12-inch and found the condensation easily; it is visible whenever the seeing is good."

Since then the writer has seen M33 at House Springs, only 30 miles from St. Louis, Mo., but I have never been able to see the galaxy from the city itself. Apparently M33 is visible to the naked eye, but only when skies are quite clear and city smog is entirely absent. I would welcome reports from other amateurs.

WALTER SCOTT HOUSTON

MOON PHASES AND DISTANCE

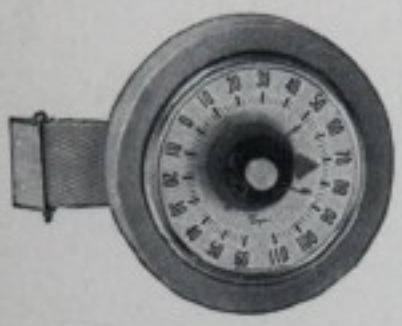
First quarter	January 1,	20:29
Full moon	January 8,	12:44
Last quarter	January 15,	22:13
New moon	January 24,	01:06
First quarter	January 31,	05:05
Full moon	February 7,	01:45

	January	Distance	Diameter
Perigee	6, 9^h	225,600 mi.	$32'\ 55''$
Apogee	18, 3^h	251,500 mi.	$29'\ 31''$
	February		
Perigee	2, 19^h	229,100 mi.	$32'\ 25''$

Low-Cost Weather Instruments For Amateurs

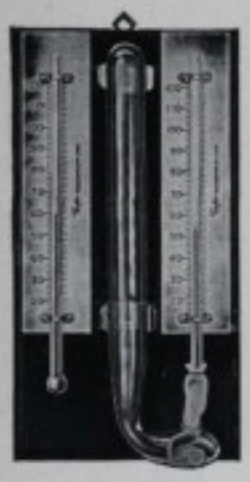
Temperature

Maximum-Minimum Thermometer



No. 116 Dial type. Pointers indicate highest and lowest readings. Easily reset by turning knurled knob at the center. Translucent back. Window bracket. Five inches diameter. **$7.50**

Humidity



Hygrometer

No. 201 Wet and dry bulb hygrometer, Mason type. Two matched thermometers with magnifying lens, range +30°F. to +120°F. Mounted on mahogany panel, 8½ x 4½ inches. Complete with water syphon, wick, and tables. **$7.50**

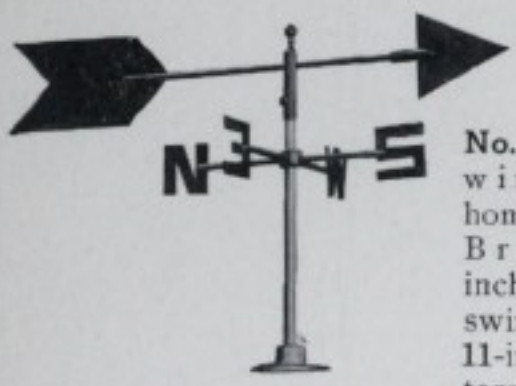
Pressure

Stormoguide

No. 311 Inexpensive aneroid barometer with helpful forecasting indications imprinted on 3-inch dial. Graduations to 0.02 inch. Polished mahogany case is 5½ inches in diameter. Adjustable for altitude. **$10.00**

No. 311A For altitudes from 3,500 to 7,000 feet. **$12.00**

Wind



Wind Vane

No. 430 Simple wind vane for home or garage. Brass vane 18 inches in length swings freely on 11-inch mast. Letters for four compass points. **$7.00**

Rain

Farm Rain Gage

No. 510 Direct reading gage fits on any fence post. Made of clear plastic with white graduations. Capacity six inches. Overall length 13 inches. Complete with bracket for mounting. **$3.95**

Write for catalogs showing full selection of amateur and professional weather instruments. Please specify your particular interest:

Temperature Humidity
Pressure Wind Precipitation

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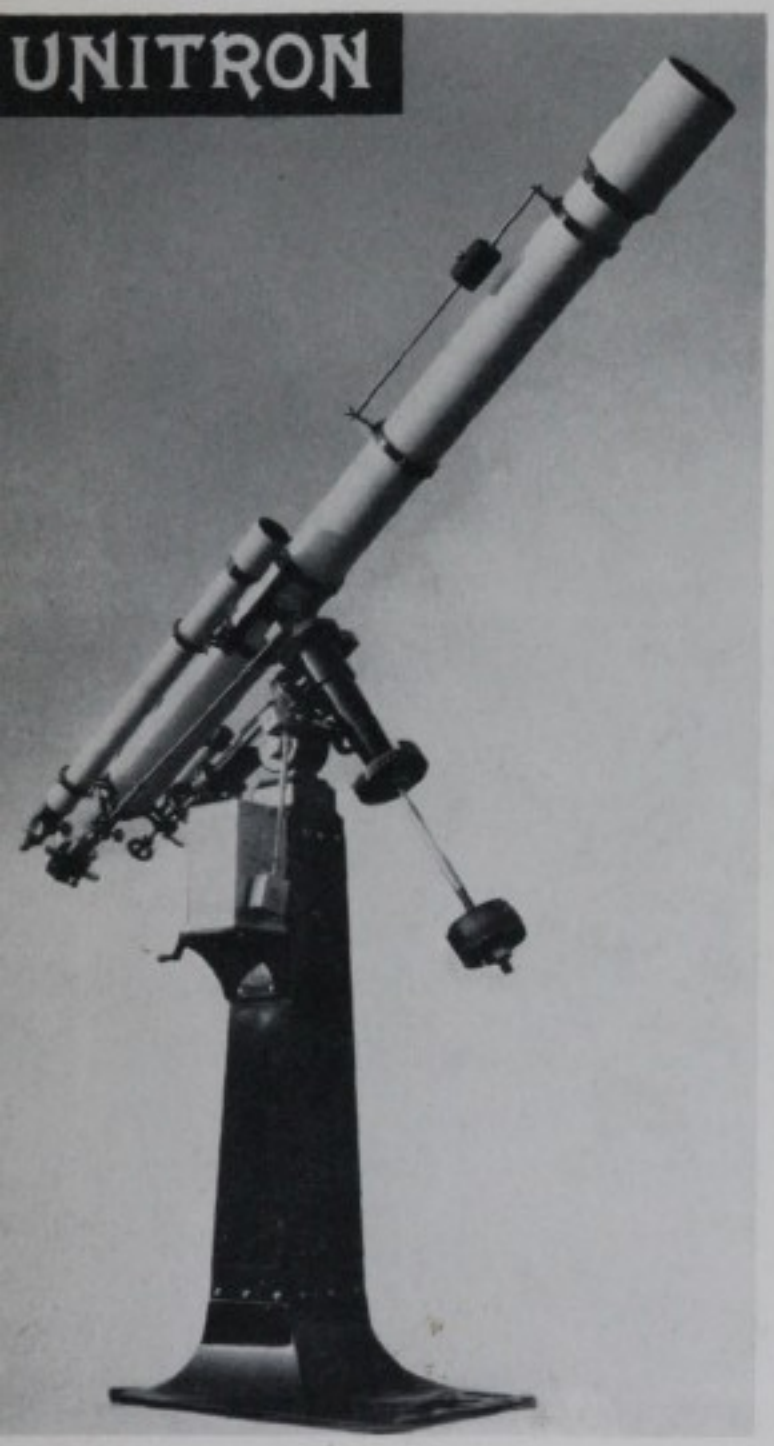
UNITRON

Prevues for 1955

An introduction to some new items that you'll be hearing a good deal more about in '55

It doesn't seem to be any secret that most telescopes of the "durable variety" sold these days are UNITRONS. What has, however, been a secret until now are the UNITRONS that haven't as yet been put on the market. Here we thought we would give you an inside look at some of the items that are currently occupying the attention of our research division.

We'll continue to keep you posted through these pages, and if you have written for our catalog on any previous occasion you will automatically receive by mail all forthcoming information as it becomes available.



Pictured above is the first of a series of test models of a forthcoming UNITRON 6-inch Refractor, with pier and drive. This instrument will be a complete observatory installation and will incorporate every convenience for observing and for astro-photography. Auxiliary equipment will include a 3-inch guide telescope, a large view finder, two astro-cameras (not shown), about 10 eyepieces and a rotary eyepiece selector, and a spectroscope, as well as the standard UNITRON accessories.

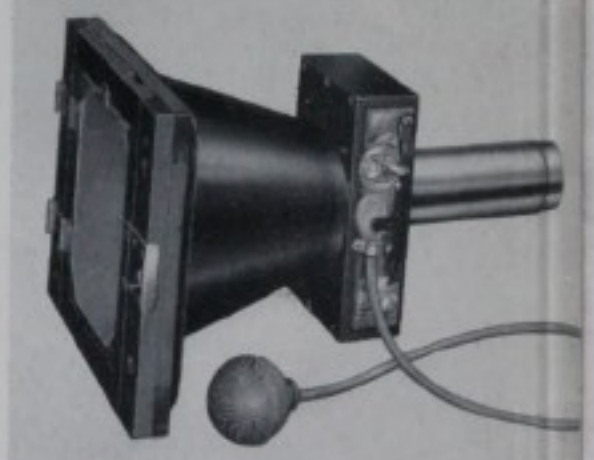
Every UNITRON instrument offered is the culmination of extensive design and redesign, exhaustive testing and retesting, to preserve the distinguished UNITRON reputation.

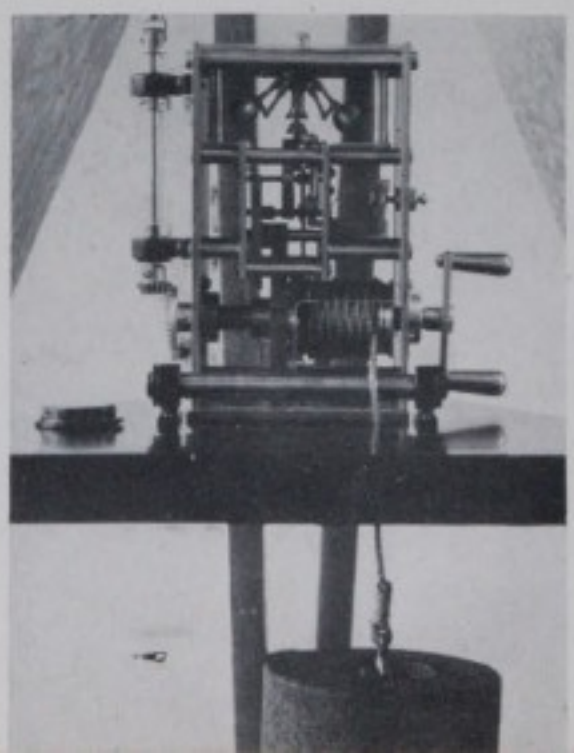
The tripod shelf on the UNITRON 4-inch Equatorial, Model 155 pictured above, has been found invaluable for holding eyepieces and accessories (as well as for storing a midnight snack for observers). It will also hold the neat little clock drive shown in detail below. This drive will also be used with the fixed pier we are offering soon for the 4-inch.

Attached to the Model 155 is the first of a number of astro-cameras that are in the works. This one (shown at the right) uses the objective of the telescope as the camera lens, with or without the eyepiece, for photographing the sun, sunspots, the moon, solar and lunar eclipses, and (with a clock drive) stars, nebulae, clusters, and comets.

Six magnifications at your fingertips! No eyepieces lost in the dark! Change eyepieces instantly while the object stays centered in the field of view! UNITRON owners will bless this accessory, which is very soon to be offered. When you want to change magnifications merely rotate a new eyepiece into position.

At the moment, for temporary lack of a better name, we refer to this handy gadget as a "Rotary Eyepiece Selector." If you can think of a more appropriate name, preferably incorporating the idea of the six eyepieces, let us know. If we use your name, we'll send you as a gift one of these eyepiece selectors just as soon as they are available for sale.





None of the new instruments and accessories shown here is as yet for sale. But as you know, there are already 9 UNITRON Refractors, which are pictured and priced on page 108.

Our catalog on these instruments is essential reading for telescope buyers, and is yours for the asking. Write for your copy to Dept. T-1.

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